DESURBS Deliverable 4.7: User manuals for the WP4 supporting tools

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1. Introduction

This report accompanies the comprehensive supporting tool package which is Deliverable 4.7 of the FP7 Security Program research project 'Designing Safer Urban Spaces' (DESURBS, Grant Agreement no. 261652). The purpose of this report is to provide short user manuals for each of the supporting tools that have been developed in WP4.

2. New industrial design security products (Bezalel Academy)

The background and DESURBS advances in new industrial design security products are reported in D4.1

2.1 HopeSpot balloon

Scope and Purpose

The HopeSpot's objective is to provide an efficient, cost-effective, accessible and portable product to ease communication challenges with crowds. It was designed as a flexible component of the supporting auxiliary infrastructure with uses during emergency and planned scenarios.

Hope Spot creates a mark in the sky, pointing survivors of large-scale disasters to places where they can get aid, or alternatively be used during planned events, such as marathons and concerts, to point out first aid locations.
For examples please see the HopeSpot clip- http://vimeo.com/94975469

The HopeSpot's helium inflated balloon is set aloft to a height of up to 50 meters or according to local aviation rules, and is capable to reach height of 300 meters or more.
It has a distinct hue that is visible in daytime, in the last prototype test reached daytime effective viability of up to 300 meters; while at nighttime LED lighted cable points toward the ground with effective visibility of up to five kilometers.

The HopeSpot balloon has been developed into a prototype, and was tested during the 2014 Jerusalem Marathon.

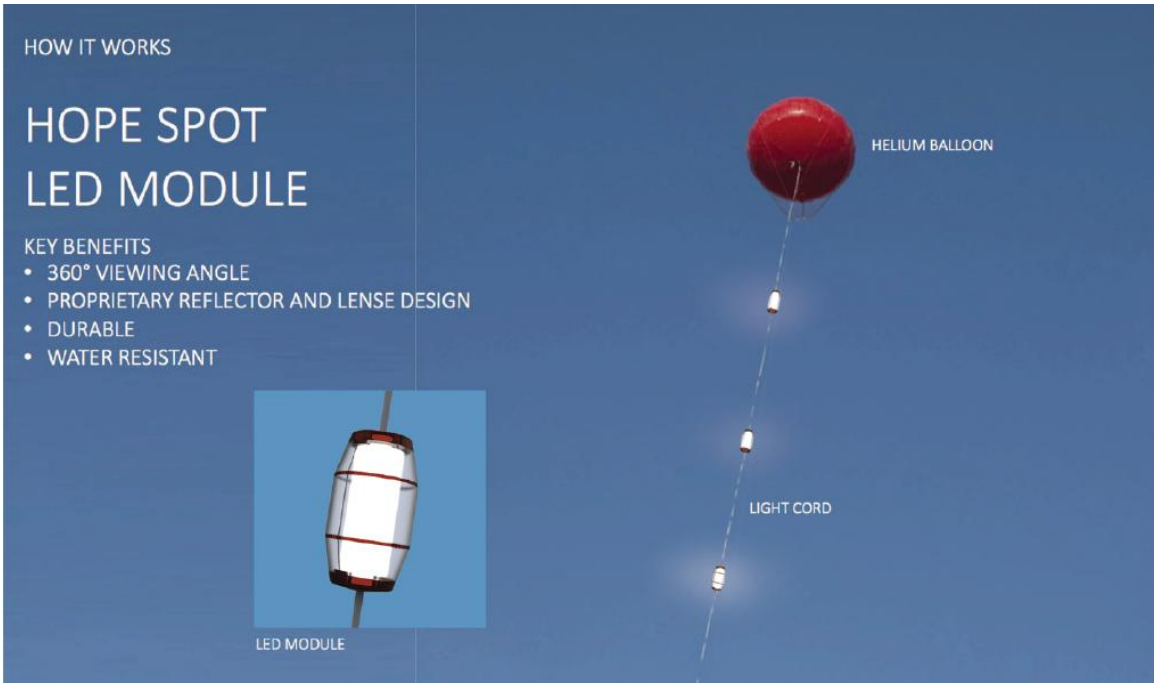


Diagram explaining the HopeSpot LED module

System Components

- HopeSpot Carrier-70 liter
- Ground insulation fabric -4 m. in diameter
- Carabineers
- Kevlar Rope-10 m. 2 mm in diameter
- 4 Pegs
- Wind indicator
- Helium -3.5 cubic meters
- Illumination cable + roll- 50 m.
- Battery
- Controller
- Balloon repair kit
- Jumper cables to connect to a fixed power source connection

Illustrative image of the system components in the carrier, including: Ground insulation fabric, Carabineer, Pegs, Helium, Illumination cable and Controller

[Folding and Launching Stages]

The system requires a single person to operate it, though it is recommended that two or three people participate in launching the system. One practice session per year is recommended to improve operator capabilities in real time.

A periodic competency test should be performed every 6 months to make sure that system components are complete and functioning

2.1.2.1 Helium tank pressure test: the pressure gauge is under the tank nozzle
An arrow on the green zone indicates optimal pressure / arrow on the red area - low pressure)

2.1.2.2 Checking the battery charge: There is an LED on the battery pack.
A green light indicates that the battery is charged / a red light indicates that the battery needs recharging.

Illustrative image showing the HopeSpot Carrier

[Getting Started]

2.1.3.1.1 Choose the launch location; the optimal launch location should be pre-selected depending on the usage scenario (i.e. in case of flooding the HopeSpot should be launched from high ground, in the event of an earthquake an open space that can provide space for a large group should be chosen as the launch spot).

2.1.3.1.2 Make sure the launch location is positioned at least 50 meters from the nearest building; you can launch the Balloon from the roof of a building.

2.1.3.1.3 Clear a 3 m. radius from sharp objects that could endanger the HopeSpot balloon during the launch

[Launching Sequence]

2.1.4.1.1 Place the HopeSpot carrier on the ground

2.1.4.1.2 Remove the ground insulation fabric and spread it on the ground and anchor with stones, soil or sand.

2.1.4.1.3 Place the HopeSpot launch kit on the defined area on the ground insulation fabric.

2.1.4.1.4 Harness the carrier to the ground with additional weight (i.e. stones) to further anchor the system in the specified area stitched at the bottom using pegs or tie it using the rope and the pegs.

2.1.4.1.5 Place the balloon valve over the helium tank nozzle.

2.1.4.1.6 Release the helium and inflate the balloon.

2.1.4.1.7 Return the empty helium container to its designated cell in the carrier.

2.1.4.1.8 Launch the balloon into the air use the drum to control the cable release.

2.1.4.1.9 Operate the illumination using a dedicated button located on the controller panel (flip up).

2.1.4.1.10 Close the carrier while checking that the helium tank is inside and the illumination cable emerges from a dedicated hatch in the carrier.

If the option is available it is preferable to attach the carrier to a permanent power source with a dedicated connector.

Illustrative image showing the launched HopeSpot prototype

[Folding Sequence]

2.1.5.1.1 Open the carrier.

2.1.5.1.2 Shutdown the lighting system on the illumination cable using the power switch (flip down).

2.1.5.1.3 Roll up the illumination cable with help of the rolling drum until the balloon is 2 meters from the ground.

2.1.5.1.4 Release the helium from the balloon using the dedicated valve; ensure that all the helium has exited the balloon.

2.1.5.1.5 Disconnect the balloon from the illumination cable, fold the balloon and return it to its dedicated cell in the carrier.

2.1.5.1.6 Release the carrier from its ground harness (stones, stakes or rope).

2.1.5.1.7 Fold the harnessing equipment into the carrier.

2.1.5.1.8 Folding the ground insulation fabric into the carrier.

2.1.5.1.9 Closing the carrier and remove it from the site.

[Maintaining System Capabilities]

2.1.6.1.1 Spread all system components outside the carrier.

2.1.6.1.2 Remove dirt and debris from the system components (thorns, mud, sticks).

2.1.6.1.3 Replace or fill the tank of helium (pressure gauge should indicate green).

2.1.6.1.4 Charge the battery (Green LED light).

2.1.6.1.5 Operate the illumination cable and make sure that all the lights are working.

2.1.6.1.6 Roll the cable onto the drum.

2.1.6.1.7 Fill the Helium balloon with clean air and check that there is no loss of air for a period of two days.

2.1.6.1.8 Fold the balloon into its designated cell in the carrier.

2.2 CityZen

Scope and Purpose

Many resources are currently utilized to ensure our cities are kept clean, safe and well functioning. The authorities' ability to maintain safety and order relies heavily on gathering and analyzing of real time information of ongoing occurrences in the urban environment. The ability to respond quickly and efficiently is very much reliant on the capability to receive accurate and relevant information fast. However, even the most advanced solutions, such as CCTV networks and smart image analysis software, are unable to capture and understand all the relevant data from around the city at all times and there is a true need for additional solutions.

Today, at a time when so many of us possess wireless, GPS enabled smart devices featuring high definition cameras, the use of this prevalent technology can aid in creating a solution.

The background of the idea behind CityZen is to create a platform that will allow citizens and authorities to cooperate in order to improve the safety and quality of their environment. The goal of the CityZen service is to provide both authorities and citizens alike with a full and accurate picture regarding issues of safety and security, transmit instant messages from the citizens to the authorities and back, both in routine and emergency times and t thus strengthen the connection between citizens and their city.

View the CityZen clip http://vimeo.com/94975467

Process Overview

CityZen offers a free GPS enabled mobile application for urban citizens, featuring real-time reporting on one hand and a back-end monitoring cloud software for the authorities' use on the other.

The CityZen application is community-driven; users can report accidents, security hazards, disturbances and disasters and follow events reported by others around their location. Users are encouraged to provide feedback for other reports and are updated about events handled by the authorities.

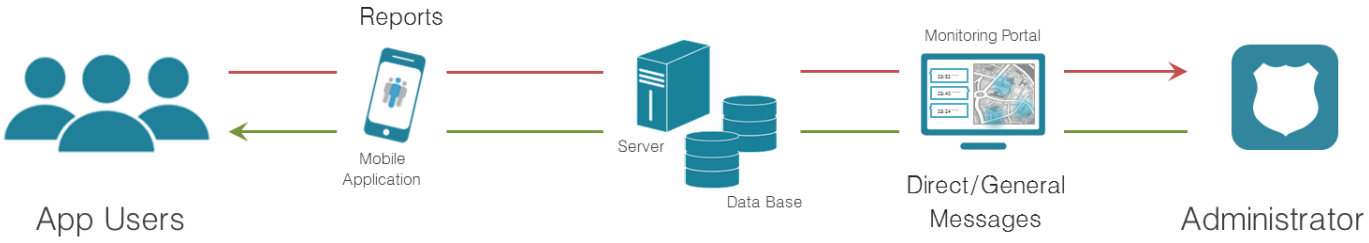
The CityZen mobile application displays a map of the city to the user allowing him\her to report hazards and security issues to different authorities using location services, voice, and imagery. In addition, the user is able to view and comment on other user's reports.

The CityZen monitoring portal allows the authorities to receive and track the reports made by citizens in real time, change the status of their handling and post messages to all the application users in close proximity.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 261652

Typical sequence for using the service:

1. A citizen submits a report regarding a hazard in their surroundings
2. More citizens confirm the report by submitting additional information
3. The authorities receive the reports, assess the event's urgency and respond accordingly
4. The authority notifies all application users about the handling
5. Citizens are aware about the safety and environmental status in their surroundings



[Browsing /Reporting / Confirming events from the mobile application]

Reporting via the application is much easier and quicker than making a phone call or using a dedicated website, encouraging more people to cooperate and share. It also reduces the cost of call centers and eliminates waiting time.

[Browsing the different events in your proximity using the MAP screen]

[Procedures for the map screen]

1. Indicator for your current location
2. Open to view a reported event
3. Report a new event
4. Show the events in a list view
5. Show my performance

[Browsing the different event in your proximity using the LIST screen]

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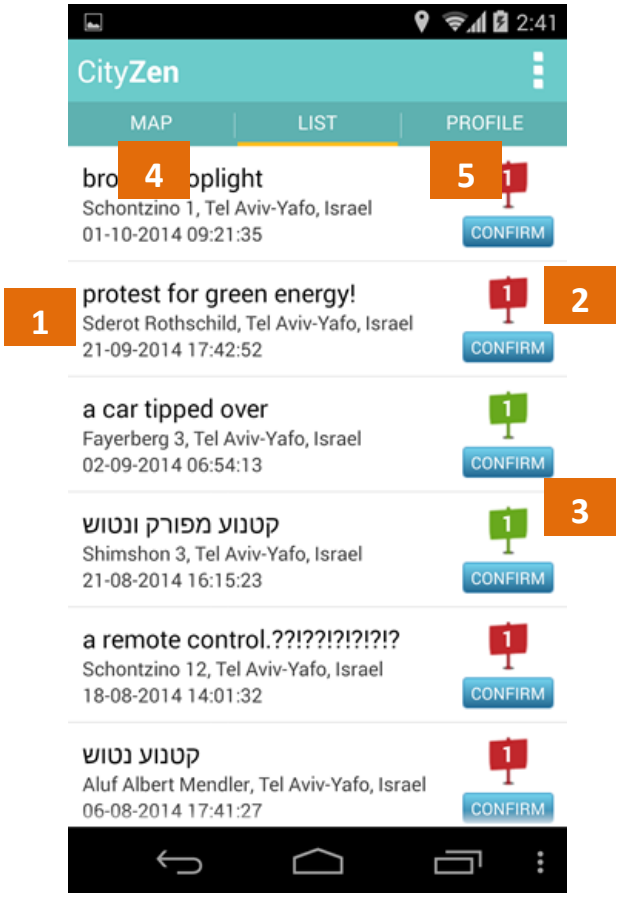
[Procedures for the list screen]

1. Information regarding a specific event
2. Indicator about how many citizens reported the event and in what the handling state is
3. Confirming an event by adding additional information
4. Show events in map view
5. Show my performance

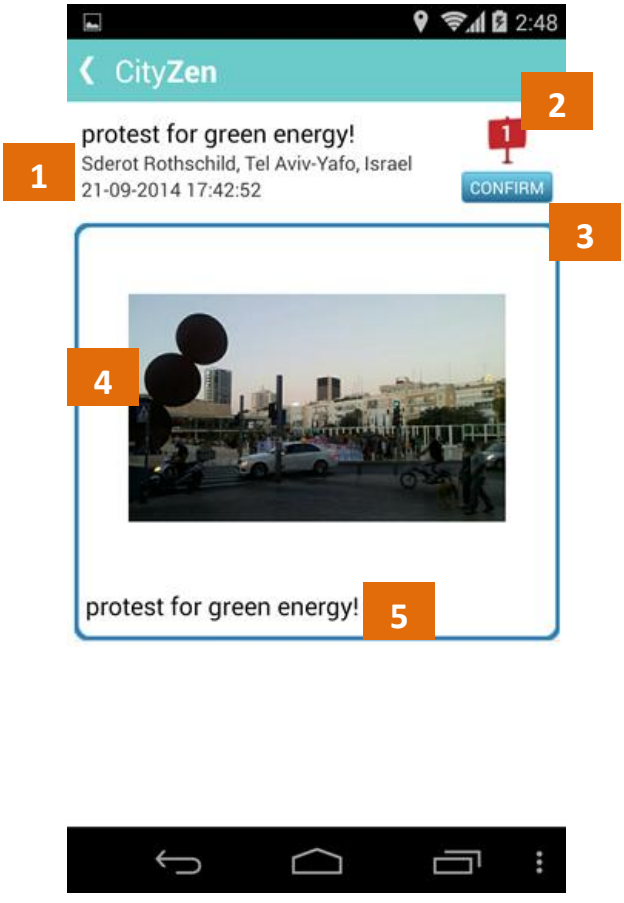


Indicator	Definition
Red	The event has been received on the authorities side but has not yet been handled
Yellow	The event is being handled by the authorities
Green	The event has been handled by the authorities

[Watching the details of an existing event]

[Procedures for the event screen]

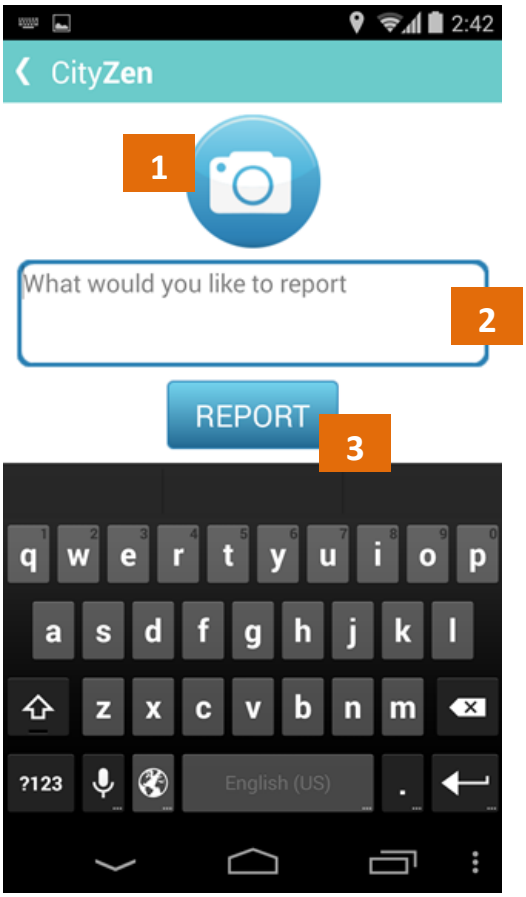
1. Information regarding a specific event
2. Indicator about how many citizens reported the event and the handling state
3. Confirming an event by adding further information
4. A photo submitted by one of the reporters
5. Text submitted by one of the reporters



[Submitting a new report]

[Procedures for the new report screen]

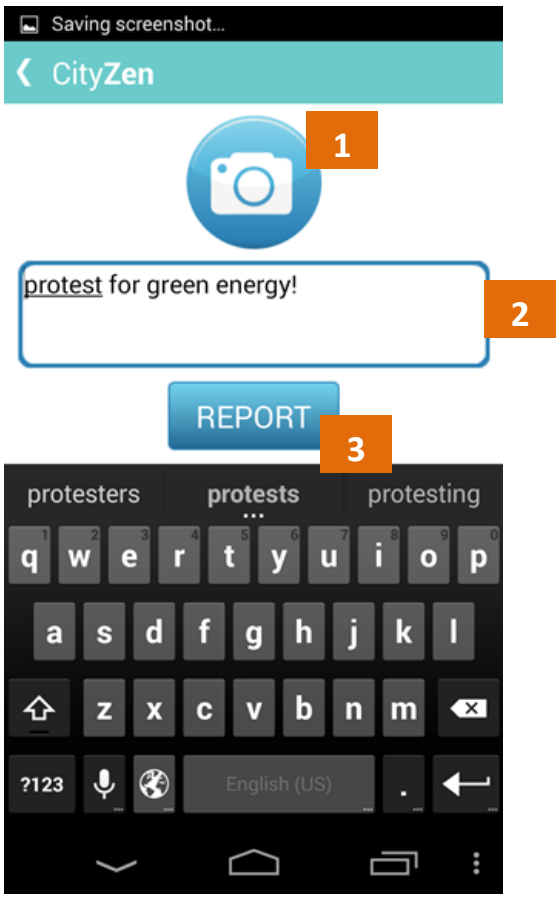
1. Take a photo or pick an existing one from the gallery
2. Text input field
3. Submit the report to the local authorities



[Confirming an existing report]

[Procedures for confirm report screen]

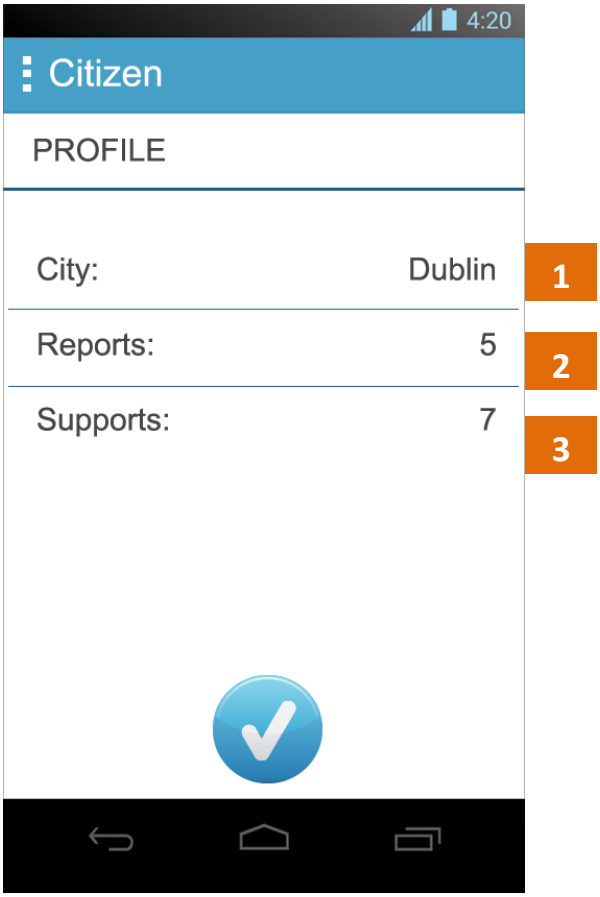
1. Take a photo or pick an existing one from the gallery
2. Text input field [default = first submitted text]
3. Submit the report to the local authorities



[Personal profile]

[Procedures for the personal profile screen]

1. The city to which the user is currently reporting
2. Number of reports the user submitted
3. Number of confirms the user contributed to existing reports



[Managing reports from the monitoring portal]

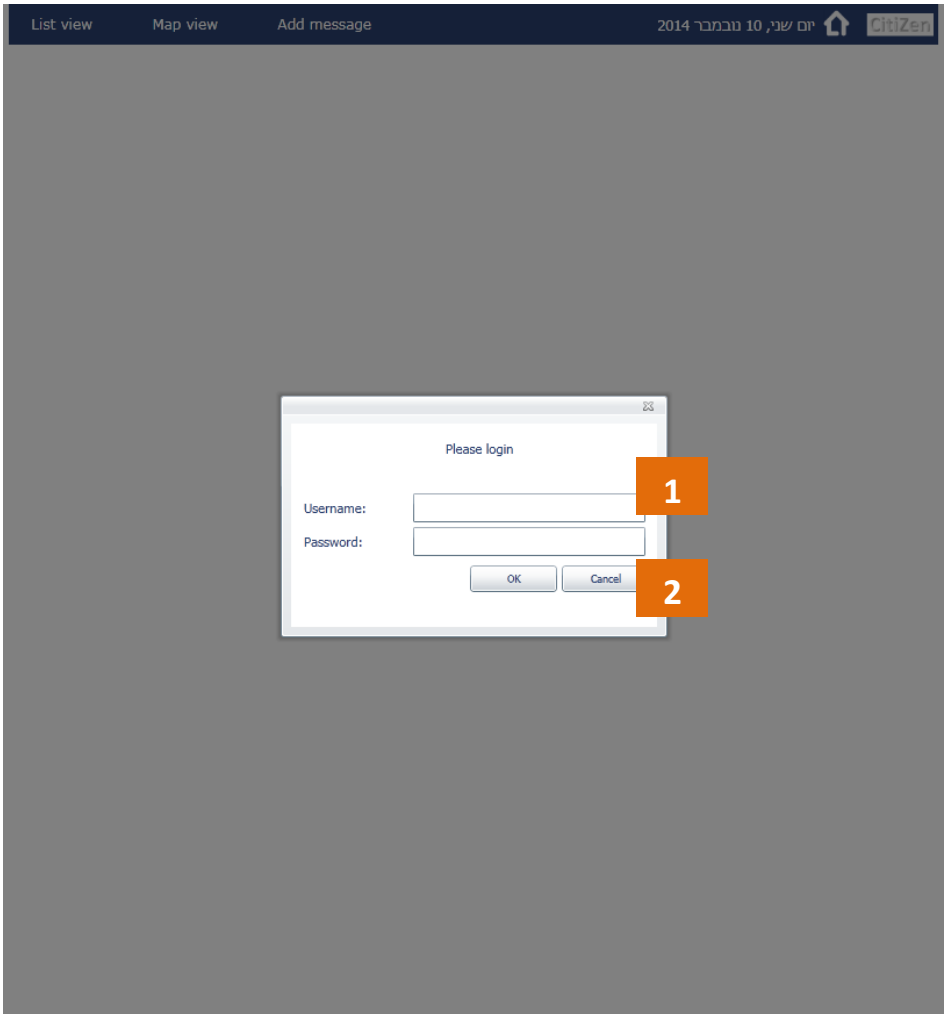
The CityZen monitoring portal is a cloud-based tool that allows the local authorities to receive reports made from the CityZen mobile application, manage their handling and post messages to civilian users.

[Logging into the system]

A username and password will be used to log in to the relevant city's control panel with predefined actions and permissions.

[Procedures for the map screen]

1. Username text input
2. Password text input

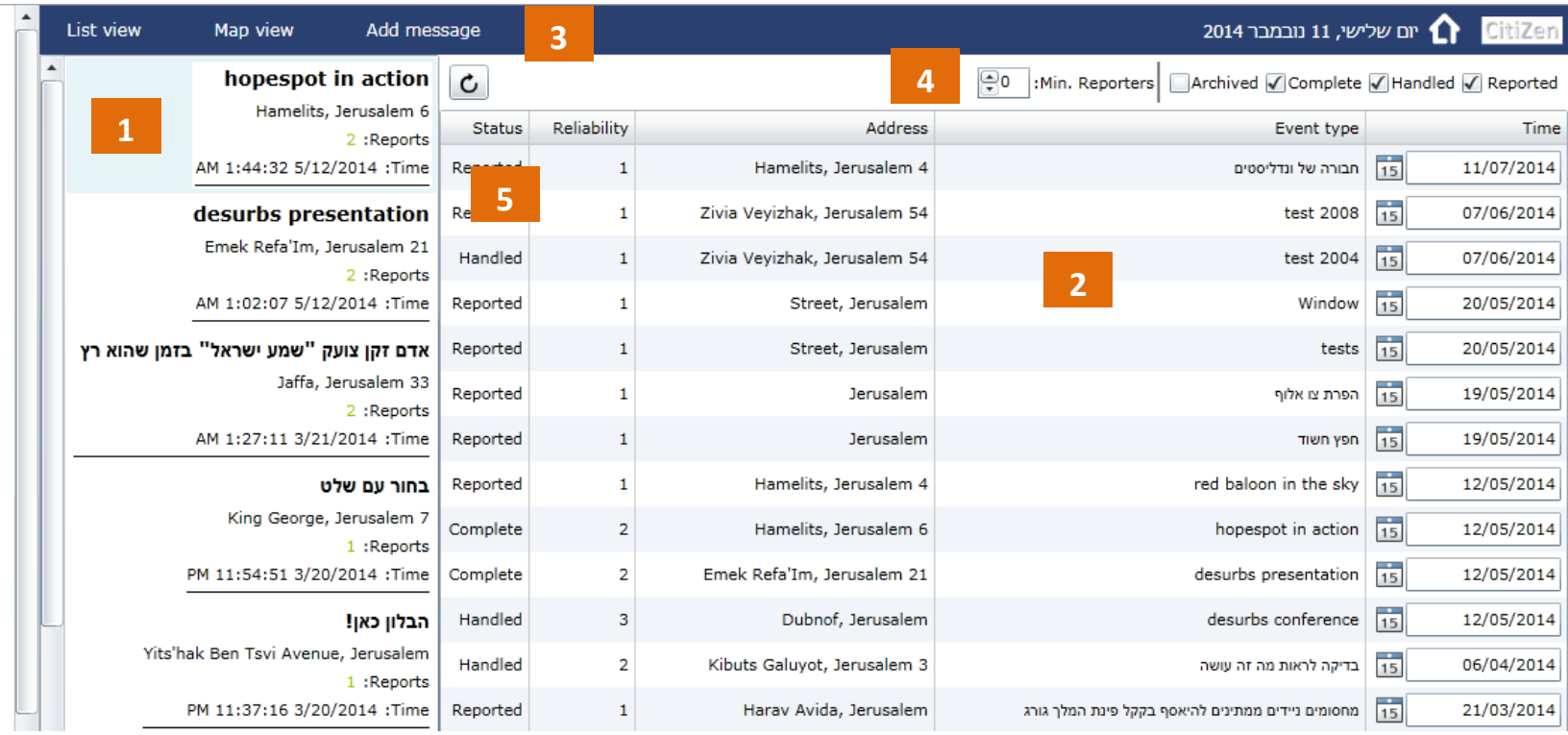


[Managing reports via the LIST screen]

The list screen shows all the recent events (most recent on top) in a table grid.

[Procedures for the map screen]

1. Event Feed
2. Table of events featuring: Time, Event type, Address, Number of reporters, Status
3. Navigation panel: allows to switch between the list and the map screens and to post a general message to all application users
4. Filter menu: selects certain reports to be shown
5. Refresh button

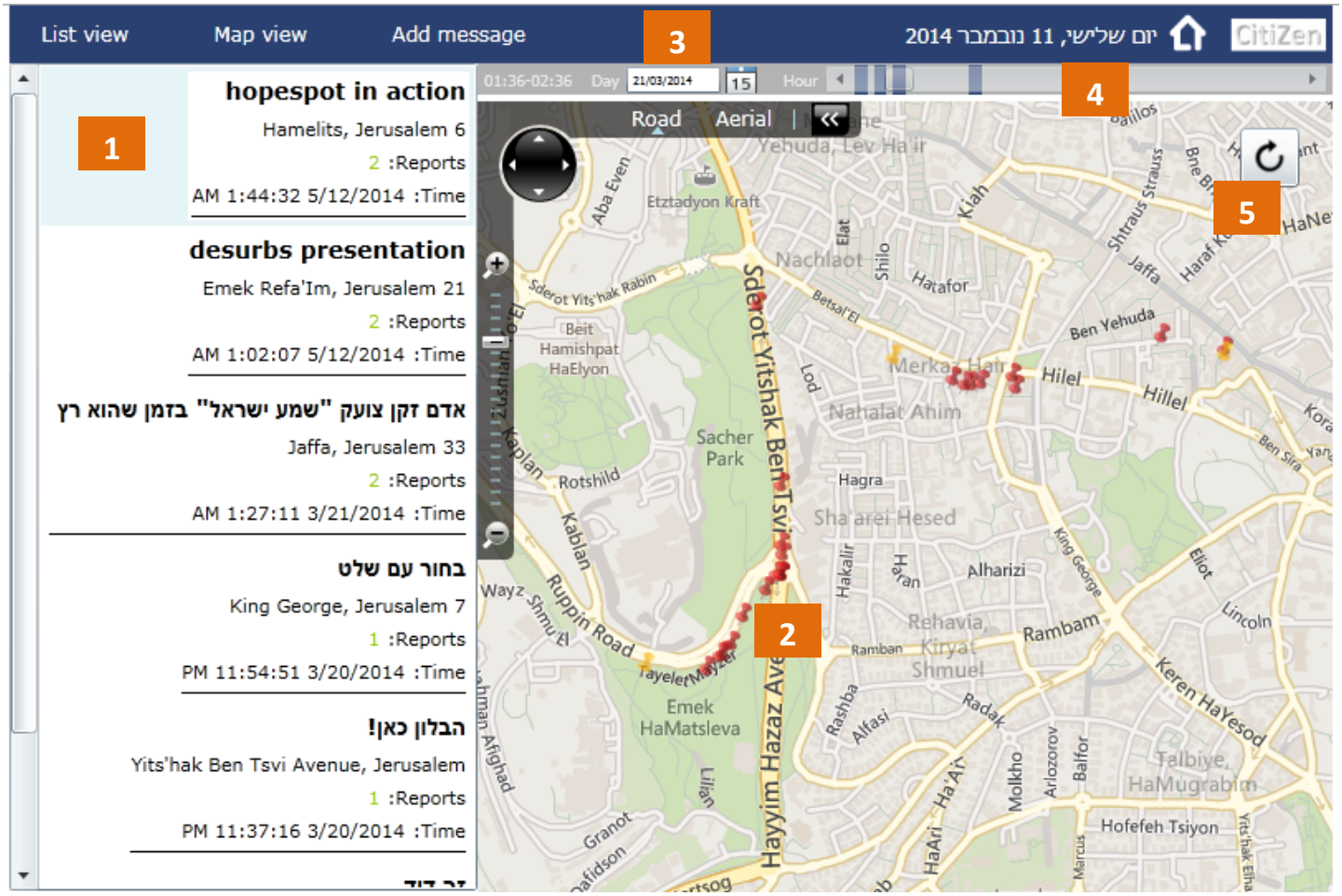

List view
Map view
Add message
3
יום שלישי, 11 נובמבר 2014
CitiZen
1
hopespot in action
Hamelits, Jerusalem 6
2 :Reports
AM 1:44:32 5/12/2014 :Time
desurbs presentation
Emek Refa'Im, Jerusalem 21
2 :Reports
AM 1:02:07 5/12/2014 :Time
אדם זקן צועק "שמע ישראל" בזמן שהוא רץ
Jaffa, Jerusalem 33
2 :Reports
AM 1:27:11 3/21/2014 :Time
בחור עם שלט
King George, Jerusalem 7
1 :Reports
PM 11:54:51 3/20/2014 :Time
הבלון כאן!
Yits'hak Ben Tsvi Avenue, Jerusalem
1 :Reports
PM 11:37:16 3/20/2014 :Time
4
0 :Min. Reporters
Archived
Complete
Handled
Reported
5
2
Status
Reliability
Address
Event type
Time
Reported 1 Hamelits, Jerusalem 4 חבורה של וגדליסטים 11/07/2014
1 Zivia Veyizhak, Jerusalem 54 test 2008 07/06/2014
Handled 1 Zivia Veyizhak, Jerusalem 54 test 2004 07/06/2014
Reported 1 Street, Jerusalem Window 20/05/2014
Reported 1 Street, Jerusalem tests 20/05/2014
Reported 1 Jerusalem הפרת צו אלוף 19/05/2014
Reported 1 Jerusalem חפץ חשוד 19/05/2014
Reported 1 Hamelits, Jerusalem 4 red baloon in the sky 12/05/2014
Complete 2 Hamelits, Jerusalem 6 hopespot in action 12/05/2014
Complete 2 Emek Refa'Im, Jerusalem 21 desurbs presentation 12/05/2014
Handled 3 Dubnof, Jerusalem desurbs conference 12/05/2014
Handled 2 Kibuts Galuyot, Jerusalem 3 בדיקה לראות מה זה עושה 06/04/2014
Reported 1 Harav Avida, Jerusalem מחסומים ניידים ממתינים להיאסף בקקל פינת המלך גורג 21/03/2014

[Managing reports via the MAP screen]

The map screen shows all the recent events over a map with graphic indicators to mark their location.

[Procedures for the map screen]

1. Event's Feed
2. City map with indicators of the local events
3. Date filter
4. Hour filter
5. Refresh button

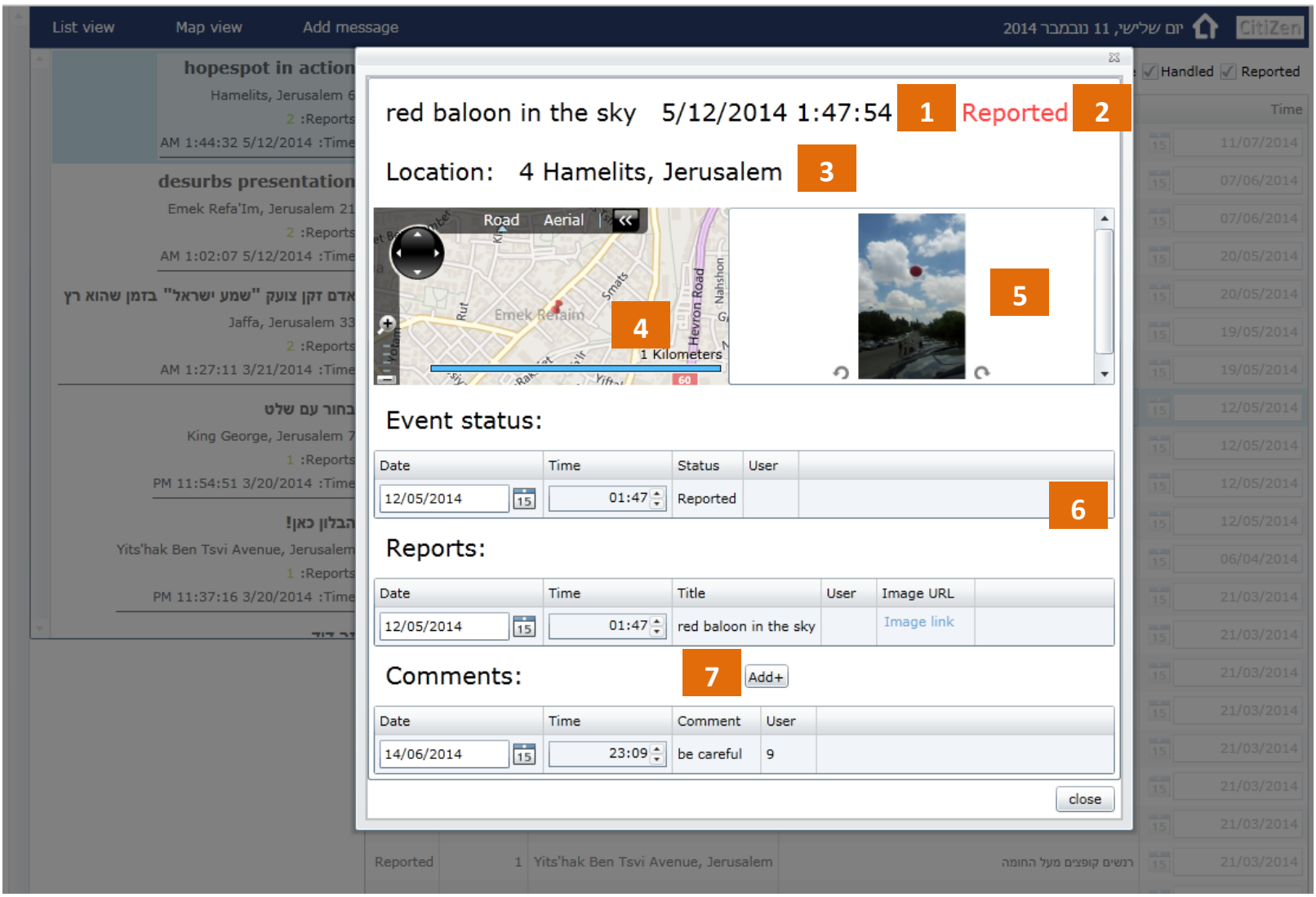


[Managing specific event]

The event screen shows all the detailed information regarding a specific event. In this screen you can find :

[Procedures for the map screen]

1. Event details
2. Event status
3. Event location
4. Event' location on a map
5. Photos submitted via mobile application
6. History of reports, status changes and comments
7. Add comment to the specific event


List view
Map view
Add message
red baloon in the sky 5/12/2014 1:47:54
1
Reported
2
Location: 4 Hamelits, Jerusalem
3
Road
Aerial
Emek Refaim
1 Kilometers
4
5
Event status:
Date
Time
Status
User
12/05/2014
01:47
Reported
6
Reports:
Date
Time
Title
User
Image URL
12/05/2014
01:47
red baloon in the sky
Image link
Comments:
7
Add+
Date
Time
Comment
User
14/06/2014
23:09
be careful
9
close

2.3 CityTalk

CityTalk is an elderly inclusive web-based communication platform, serving as a bridge between urban planners and the community.

City resilience relies first and foremost on the safety, security and quality of life of its inhabitants. The ability to construct such a city depends on understanding the needs, wishes and difficulties of the people who live in it. The rise in percentage of elderly as part of the population, combined with the many challenges posed to them by city life, require paying special attention to their needs in the process of urban planning.

The aim of the CityTalk project is to examine the city through the perspective of the elderly in order to be able to provide real solutions to issues revealed by qualitative research.

At this stage CityTalk has completed a comprehensive research stage and presents a conceptual framework and mockup product for the next phase of development and programming.

The research covered the following:

Theoretical Context, The Aging Process, Physiological Changes, Social Changes, Cognitive Changes, A cognitive interplay of Transitions, Aging Well ,Successful Aging , Active Aging, Behavior Modification , Behavior Modification Through Design, Behavior Modification in the Urban Context, Public Participation in Urban Planning, Public Participation , Principles and Methods, Public Participation in Israel, Technology and the Elderly, Technology and Old Age and Accessibility Guidelines.

[CityTalk Communication Platform]

CityTalk is a web-based communication platform between the urban planner and the community. It consists of an interface for the community and an interface for the urban planners, or the community worker operating the platform.

The Community Interface

The community interface provides 3 basic functionality options for the user.

- The first one includes viewing of building projects in proximity to user.
- The second option allows one to answer questionnaires sent out by urban planners, providing an opportunity to participate in setting priorities for spatial planning.
- The third function provides a place for expressing and sharing thoughts regarding the built environment allowing the community to interact and communicate and perhaps raise the public's awareness to issues needing attention.

Accessibility features include:

- use of high contrasting colors,
- color differentiation between functions,
- text sixe,
- stable and consistent use of site structure,
- constantly visible menu for easy navigation,
- an option for changing the language and transferability of the interface to different media platforms.

Community interface of CityTalk

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 261652

The facilitator interface

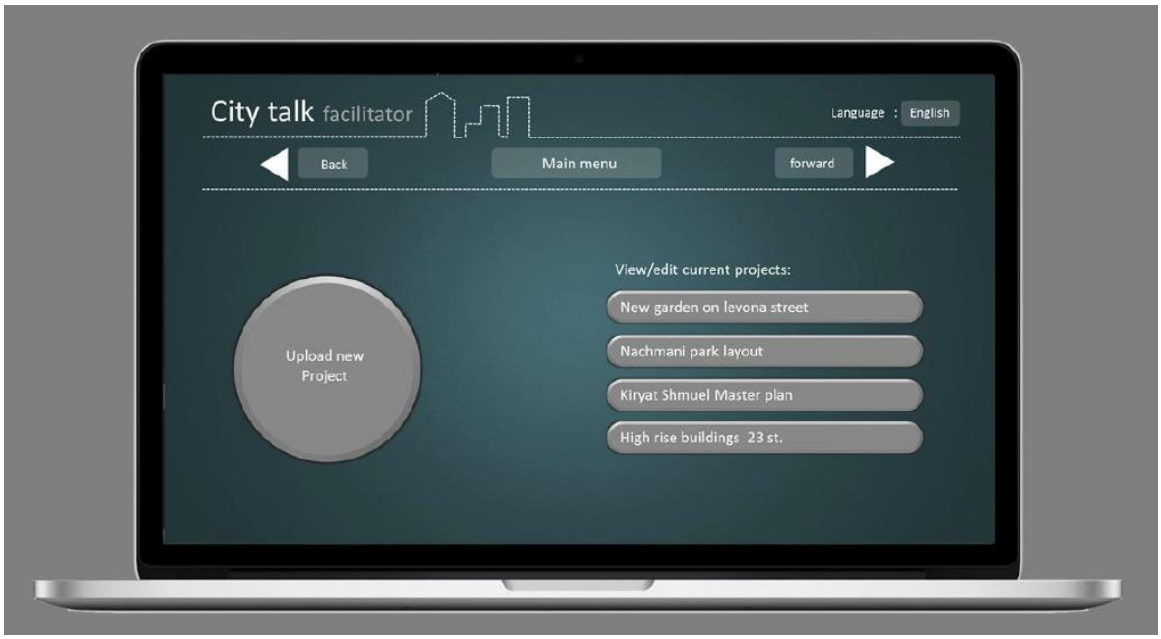
The facilitator interface allows for two primary functions.

- The first one includes uploading of new projects
- The second includes viewing and editing of ongoing projects.

  Each of these two basic functions provides further options for the planners.

- The 'Upload a new project' functionality gives the facilitator access to demographic information from the area, allows him to access demographic relevant planning manuals and supplies him with a tool to form a questionnaire or to choose one from a list of templates in the program.
- The 'edit and view existing projects' functionality, allows the facilitator to view results of questionnaires, update projects status, and respond to projects comments.

The facilitator interface is built to ensure easy and intuitive operation of the site by the user. This is done by providing a basic template the facilitator must fill in when uploading project. Images can be dragged into location and text can be typed straight into specified text box. This user friendliness is crucial if one doesn't want project to fail due usability problems on the planners end.



Facilitator interface of CityTalk

2.4 Urban Resilient Design Guidelines

Scope and Purpose

The Urban Resilient Design Guidelines (URDG) is a manual produced in paper and pdf formats that aims to highlight various types of information available to support resilient planning and stress the importance of analyzing different data layers to create a comprehensive picture of the existing situation. The URGD details a number of outputs from the DESURBS project and makes recommendations for optimal use of new industrial design security products in the mapping process.

- The URDG proposes a GIS (Geographical Information System) based method with layers that apply the Integrated Security and Resilience (ISR) design framework to identify vulnerabilities and improve urban spaces through a stage-by-stage process.
- The combination of layers and information is essential for understanding the evolving urban space in greater detail, helping planners and stakeholders map vulnerabilities and design options as part of the statutory process.

The URDG promotes secure urban design and planning, generating awareness regarding the impact of different urban phenomena on urban resilience (see clip-www.vimeo.com/93713153) . The guidelines showcase several incidents, explains how to apply GIS (Geograpgic Information Systems) in order to analyze them and assess the vulnerability, and suggests industrial design products developed especially for the DesUrbs project that are available to aid in both preparedness and mitigation. A basic understanding of GIS is needed to use the guidelines and create the maps.

Process Overview

The URDG proposes a framework to help cope with risk preparedness.

The Bezalel DESURBS team has developed a number of innovative products that contribute to the creation of safer urban environments, including the HopeSpot Balloon, CityZen and CityTalk: these tools address a wide range of possible events (crime, terror, accidents, natural disasters and inclusive planning) that threaten the urban populations and environments. These tools were designed to aid in creating and maintaining safe spaces on a daily basis and during emergency events.

At a site-specific level of planning, once the recommended layers for resilient design have been collected the ISR (Integrated Security & Resilience) stages provide a framework for analyzing the mapping data and decision-making. The ISR process helps identify urban vulnerabilities and improve urban spaces with respect to security threats.

The ISR framework stems from the literature reviews and data collection/analysis that have been undertaken over the duration of the project. The international risk management standard ISO 31000 ‘Risk management – Principles and guidelines ‘ (British Standards Institution, 2011; 2009) presents four stages, those being risk

identification, assessment, evaluation, and treatment. In the ISR framework, 'treatment' has been expanded into two stages, to aid end users to 'identify' what measures can be used, and to 'prioritise' them in relation to their effectiveness (see Bosher, 2014).

The maps created will show the planner and decision-makers strengths and vulnerabilities in the vicinity and potential long-range impacts. Using these tools planners and decision makers can reach better-informed conclusions for management the economic, social and environmental implications during both routine and emergency events.

	ISR Stage	Descriptor
1	Identify, characterize, and assess hazards/threats	**Hazard/Threat identification –** the process of finding, recognising and describing hazards/threats to which the space is exposed. Hazard/Threat identification involves the identification of: • Type of hazard/threat • The events/circumstances when the hazard/threat is prevalent • Their causes • Their potential consequences It involves: • Assessing historical data, • theoretical analysis, • seeking informed and expert opinions, and • understanding stakeholders' needs.
2	Assess the vulnerability of urban spaces to specific hazards/threats	**Vulnerability assessment** is the process of assessing the susceptibility of the intrinsic properties (the structure, materials, construction and planning) to a hazard/threat that can lead to an event with a consequence
3	Determine the risk (i.e. the expected consequences of specific hazards/threats on specific assets)	**Identifying the level of risk** - magnitude of a risk or combination of risks, expressed in terms of the combination of the likelihood (chance of something happening) and the impact (consequences) of an incident caused by that hazard/threat. It utilises a **Risk Matrix** as a tool for ranking and displaying risks by defining ranges for consequence and likelihood
4 5	Identify ways to reduce those risks Prioritise risk reduction measures	1. **Inherent safety** (eliminate the possibility of hazards/threats occurring) 2. **Prevention** (reduce the likelihood of hazards/threats) 3. **Detection** (measures for early warning of hazards/threats) 4. **Control** (limiting the size of the hazards/threats) 5. **Mitigation** (protection from the effects of hazards/threats) 6. **Emergency response** (planning for evacuation and access for emergency services)	**Identifying (and prioritising) a course of action to address and treat the hazard/threat and its associated risks**. Treatment can involve: • avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk; • removing the hazard/threat source; • changing the likelihood or magnitude; • changing the consequences; • protecting assets/spaces from the effects of the risk • preparedness planning for the impacts of risks (events) • sharing the risk with another party or parties [including contracts and risk financing]; and • retaining the risk by informed decision making

[Mapping for Resilience]

In order to begin the mapping process GIS (Geographic Information Systems) software is needed. GIS is a comprehensive and widely available tool that allows users to use a single database and perform a wide range of activities- including mapping, modeling and analysis.

[Access GIS]

In the event that you do not have permanent access to GIS, it is possible to access a free trial for the leading software for most government agencies.
http://www.esri.com/software/arcgis/arcgisonline/evaluate.

Free open source software is also available, such as Grassgis, Qgis and more.

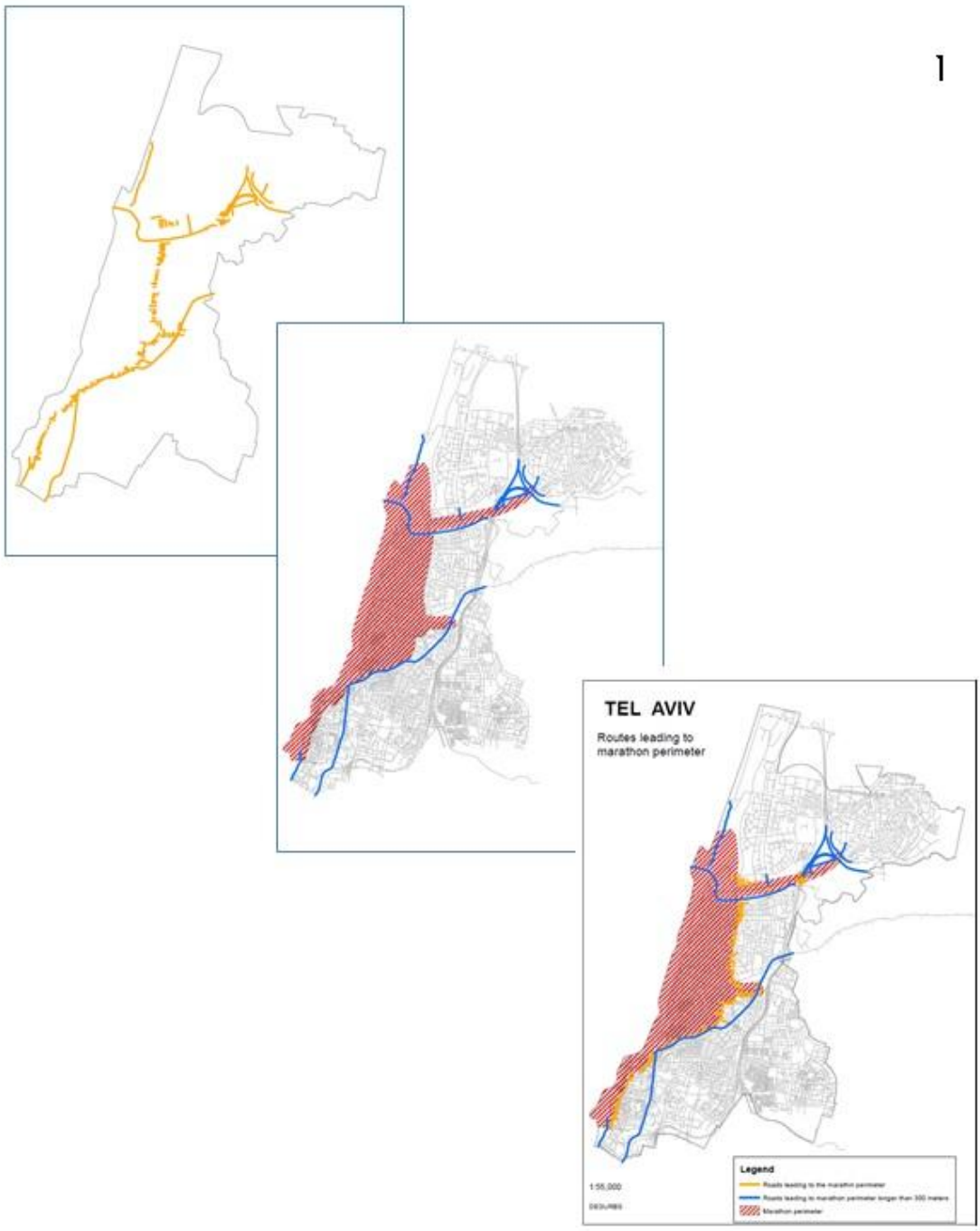
[Collect Layers of Data for Resilient Design]

The first step towards mapping for resilience is to collect data from different departments that can aid in creating a comprehensive spatial analysis that can serve as the basis for future designs and plans. Instead of planning solely for the population or a single issue you can plan for a number of factors and thus provide wider address to the city and the community, as integrating behavioral information can provide knowledge for resilience.

Examples of Layers for Resilient Design:

- Geo-morphology – Earthquakes, Tsunami prone areas, Mudslides, Flood plains.
- Areas of management of Police, Health Institutions and Fire Brigades
- Street Crime, Car Theft
- Land uses
- Public Events Venues
- Transport

Data for maps should be formatted either in a GIS format or an excel tables. GIS formats include .SHP and .GDB files. Excel tables can be appended to the GIS data using various tools including union, append and join. It is recommended that while creating the tables to include a column identical to the GIS data so that the joining will be easier.



Example: Layers of information superimposed

[Types of Data]

- For linear data, a street name or code can be used in the tabular data, i.e. routes closed for parades need to have the exact street code used in the municipal GIS system.

- For point data such as police barriers or water distribution points it is advised to use x,y coordinates or a street address (street number and entrance). For polygon data one can use the building ID or x,y of centroid. In this manner it is easier to fill out a table with local data and information and afterwards to include it in the GIS and use the data in map creating.

Example: Collecting and Using GIS Data sourced from the DesUrbs CityZen App

Within these definitions, we can also add information collected from residents and not solely from official stakeholders. The DESURBS CityZen application, an image and GPS reporting Smartphone application for two way communication between citizens and the authorities, can collect x,y coordinates from live reports made by residents or visitors who provide real time information regarding problems areas in the city. These reports can be compiled into a comprehensive database that can be used to spot recurring events and identify vulnerability trends.

After the various layers are set within a central database, the layers should be compiled into a single map.

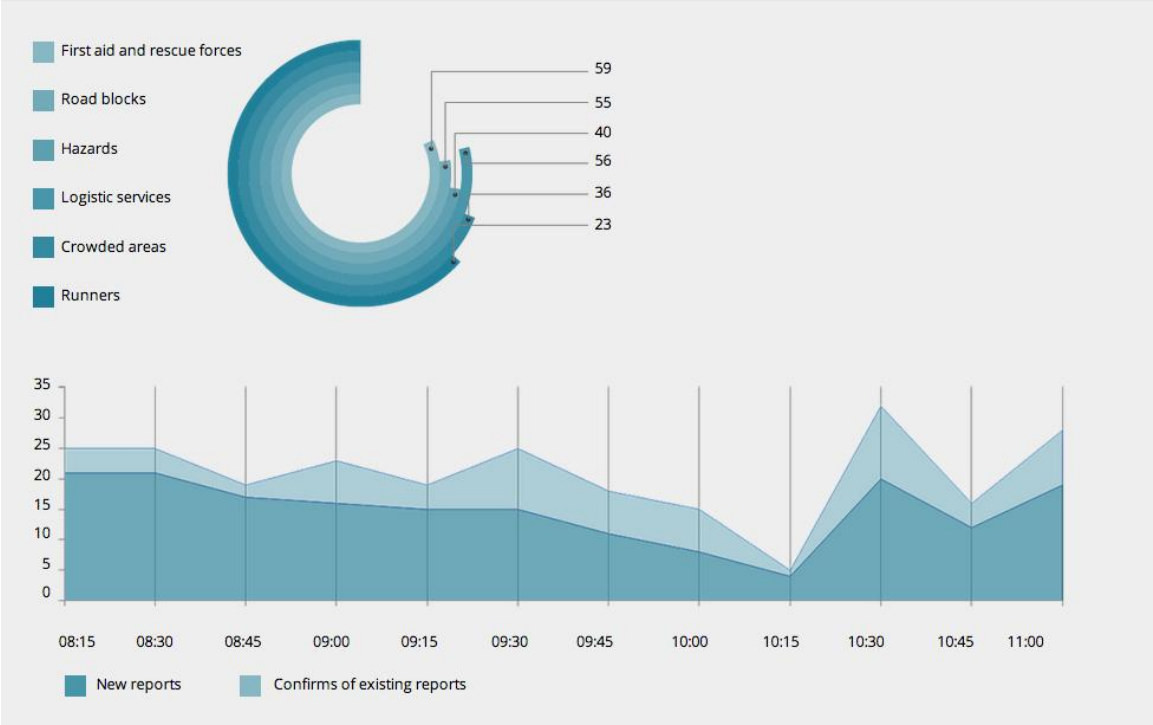
- Putting too much information in one map can distort and warp the perception of urban life and become visually disorienting. Therefore each layer should also be visualized in separate maps. The result will feature many maps that display the data from each layer along with other maps that displays all the layers together, super positioned one on top of the other in the same color but in a semi-transparent manner so that areas which will eventually seem opaque are actually the areas in which many semi-transparent urban features are flagged as problematic.

- The opaque areas will help identify vulnerable perimeters which stakeholders should consider when they are dealing with future planning opportunities. After the main map is drawn, stakeholders should examine it and determine whether their information has affected the aggregated map.

- Stakeholders should check if their information contributed to the general overview or if local professional knowledge remained unexploited.

- There are different types of GIS analyses that can be utilized on this type of map. Firstly the most opaque areas should be digitized and transformed into a stand-alone layer. This layer needs to be analyzed so that urban features identified within these perimeters are taken into account in future planning programs.

For more information on Spatial Analyses visit: http://www.esri.com/products/technology-topics/spatial-analysis



Example of Data Analysis Sourced from CityZen

For optimal accuracy every stakeholder must be responsible for keeping their data up to date. It is crucial to mention when the data was processed and collected to ensure that the maps produced have optimal accuracy. There are three indicators for data quality that should be considered: reliability, precision/ scale and sourc

3. DySTUrbD (HUJI)

The background and DESURBS advances for the DySTUrbD urban catastrophe management simulation tool are reported in Deliverables 4.2, 4.3 and 4.4. The complete DySTUrbD user manual can also be found in the appendix section at the end of Deliverables 4.2, 4.3 and 4.4.

Downloading, installing and running a model

In order to run a model, perform the following steps:

I. Download the 'Repast Simphony 2.0' suite by clicking the appropriate link on the portal.
II. Install Repast Simphony 2.0 on your computer by double clicking on the downloaded file and following the installation instructions.
III. Download the desired model by clicking the appropriate link on the portal.
IV. Uncompress the downloaded file, no specific location is required.
V. On the start menu, under all programs, find the folder RepastSimphony-2.0 and expand it (Figure 2.1).

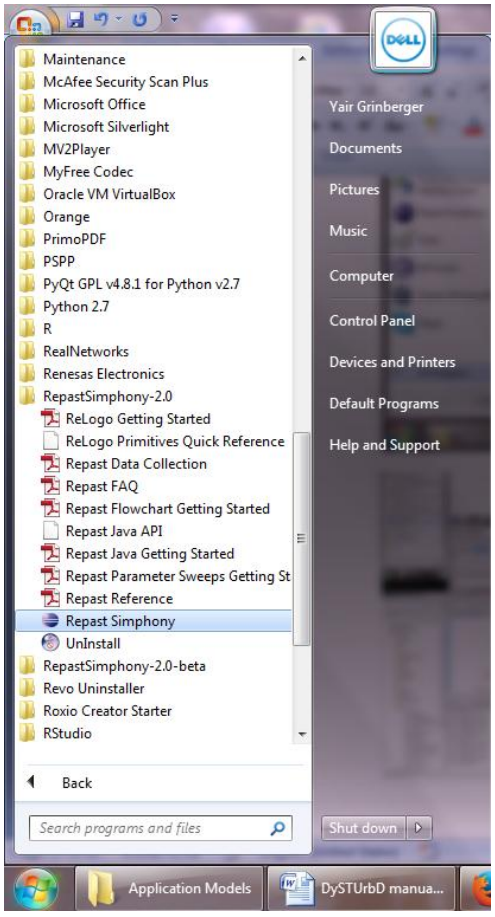


Figure 3.1. Repast Simphony 2.0 folder.

VI. Click on the 'Repast Simphony' icon.
VII. An intro screen will load. Following it, specify any folder of choice as your workspace (Figure 3.2).

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 261652

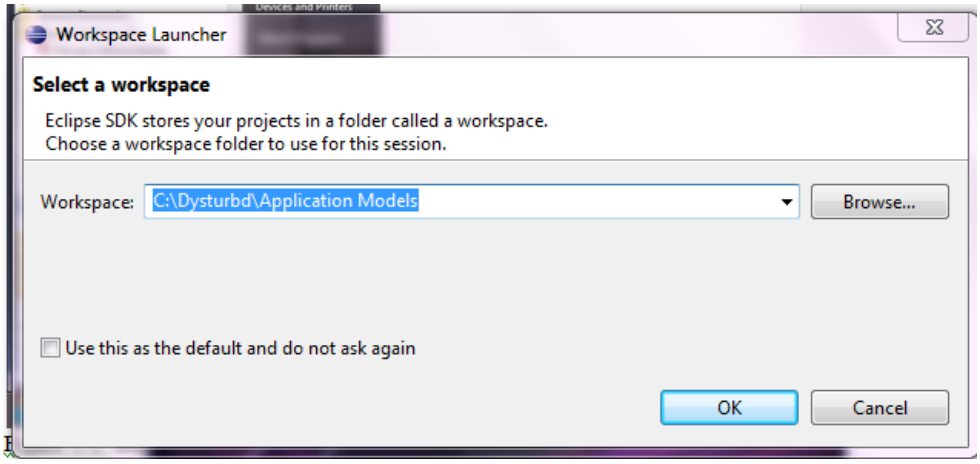

Workspace Launcher
Select a workspace
Eclipse SDK stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.
Workspace:
C:\Dysturbd\Application Models
Browse...
Use this as the default and do not ask again
OK
Cancel

Figure 3.2. Specifying a workspace folder.

VIII. On first use, the Eclipse SDK loads with no imported models (Figure 3.3). When specifying a previously-used workspace, all models are imported along with their settings.

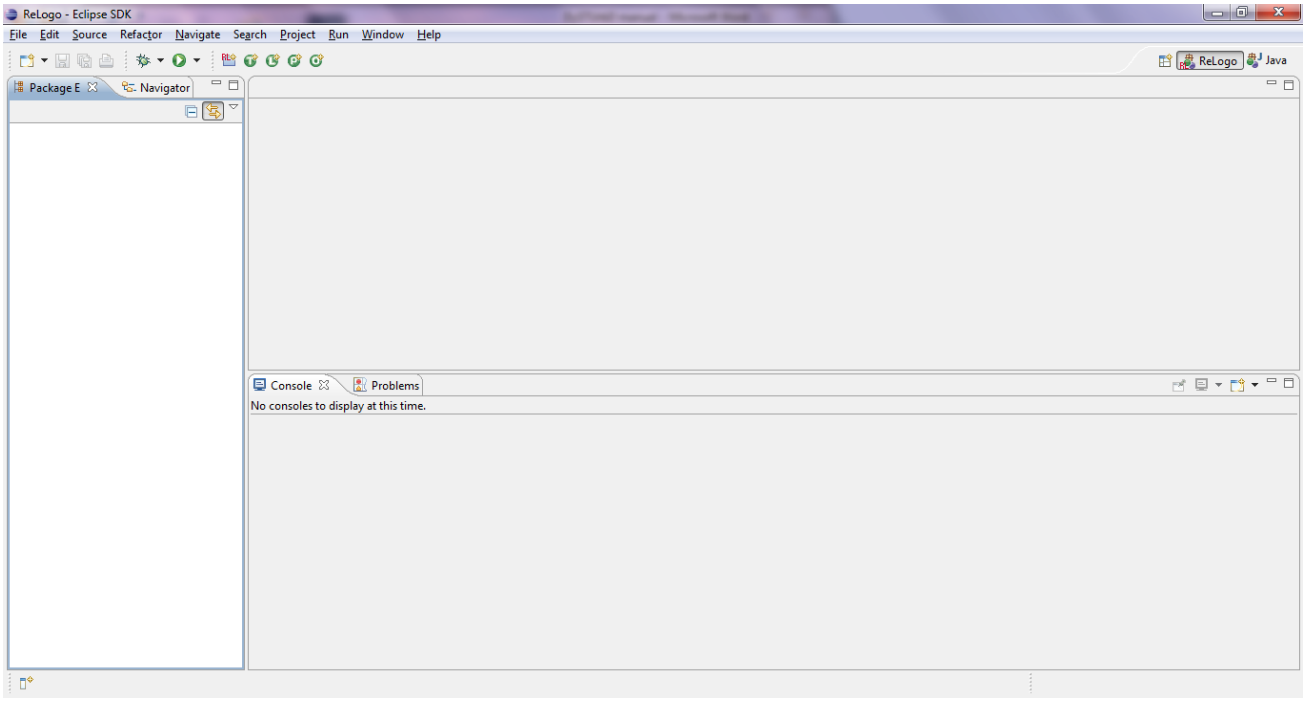


Figure 3.3. The Eclipse SDK interface.

IX. Choose 'Import…' on the 'File' menu (Figure 3.4).

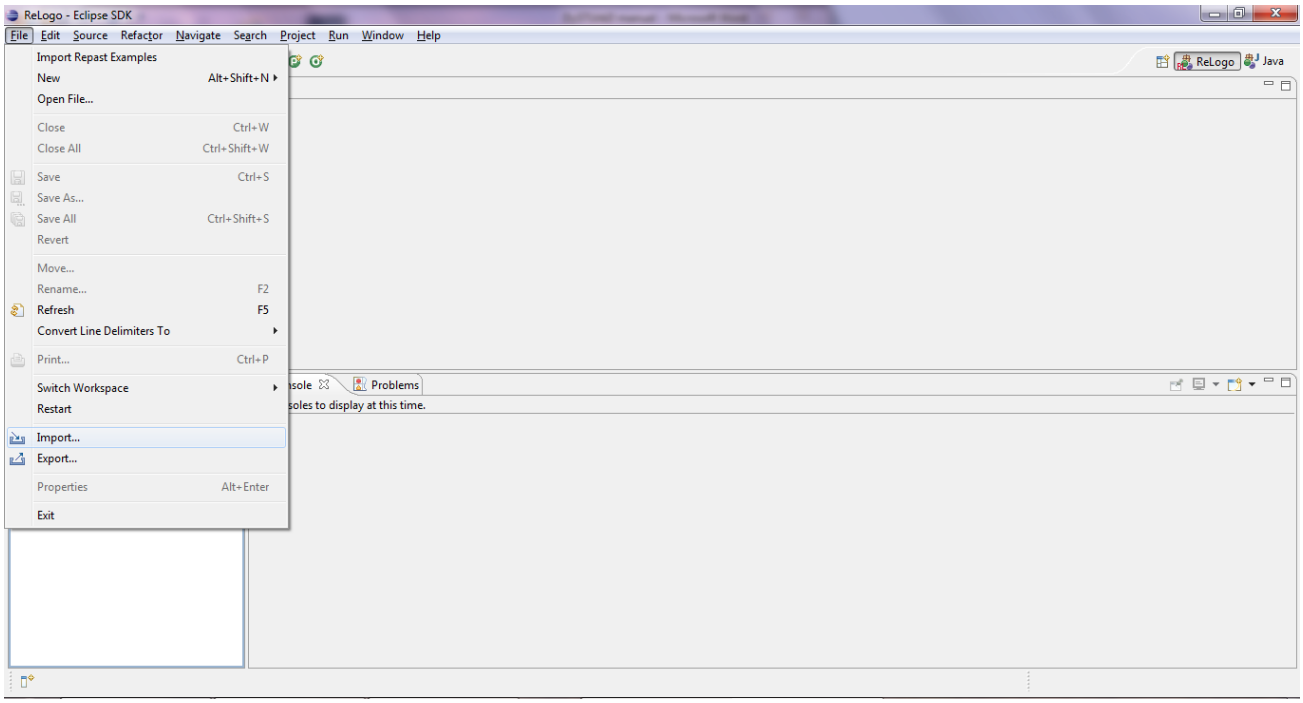
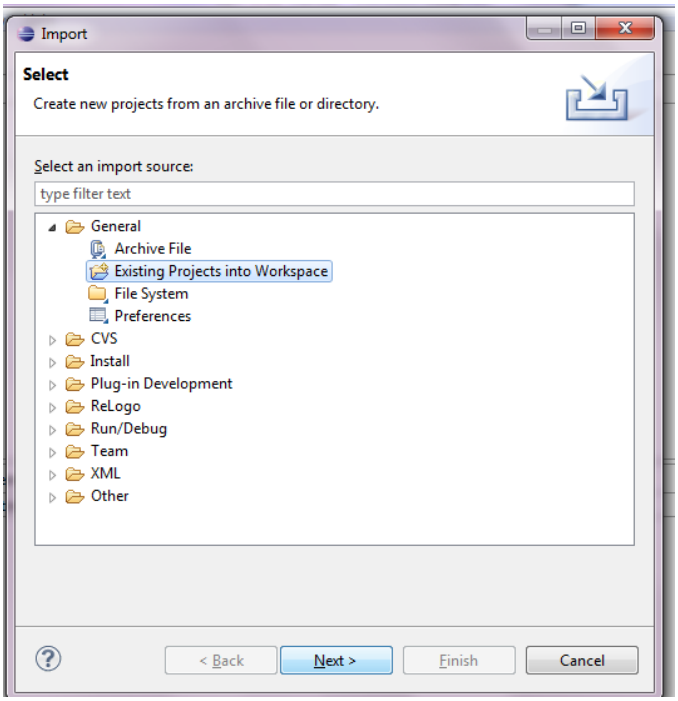


Figure 3.4. Importing a model.

X. Expand the 'General' folder on the Import screen. Choose 'Existing Projects into Workspace'



and press 'Next' (Figure 3.5).

Figure 3.5. Importing an existing project.

XI. Select 'Browse…' on the next screen (Figure 3.6).

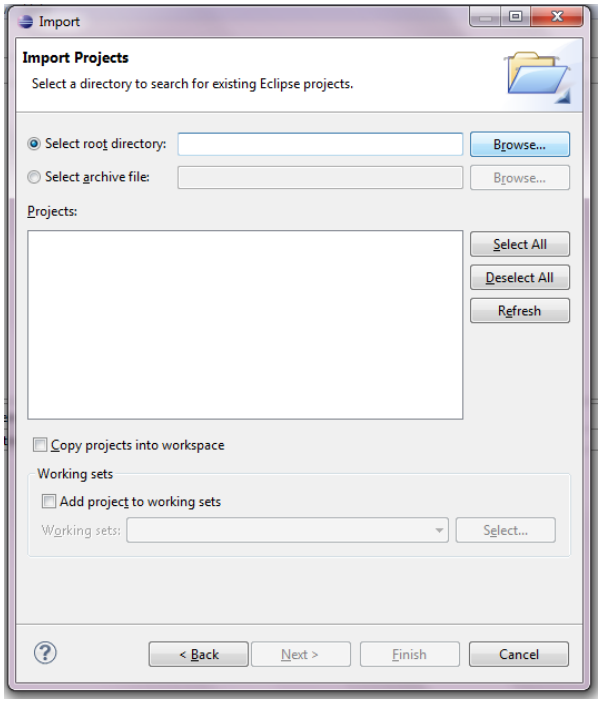


Figure 3.6. Locating the models.

XII. Navigate to the folder where you have uncompressed the downloaded model. Select this folder and press 'OK' (Figure 3.7).

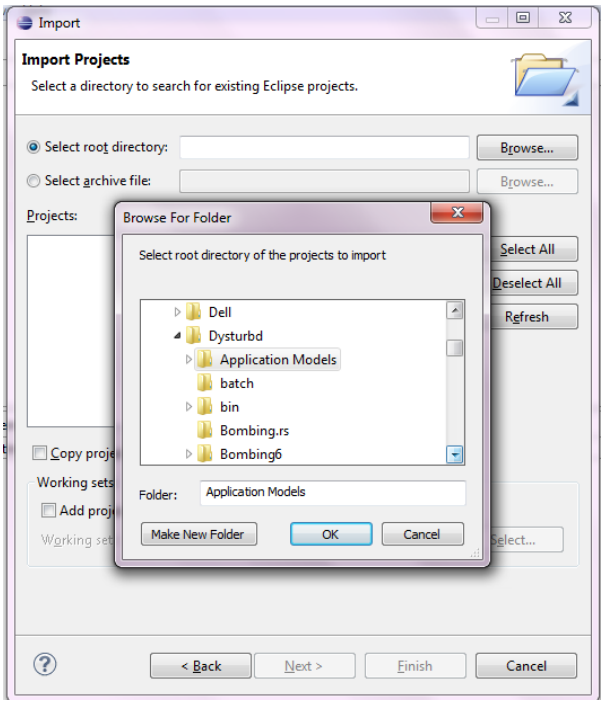


Figure 3.7. Locating the model.

XIII. All models located in this folder are automatically identified. After checking the model(s) to import press 'Finish' (Figure 3.8).

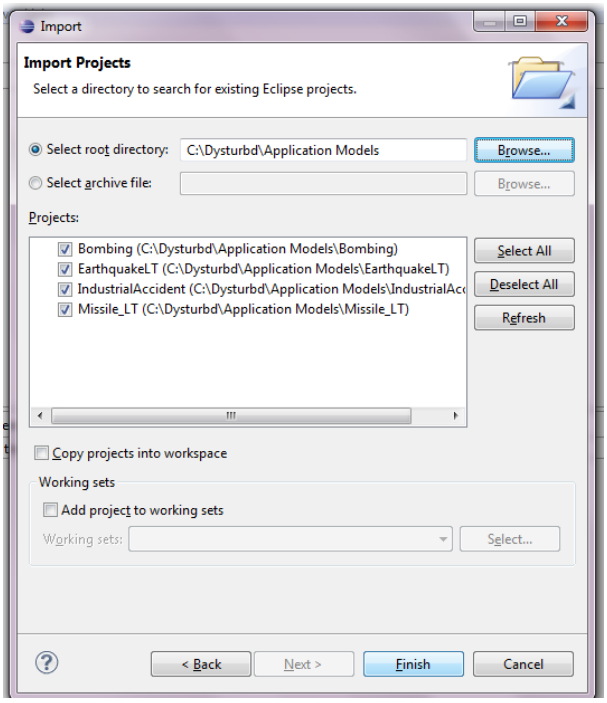


Figure 3.8. Selecting a model to import.

XIV. All imported models appear on the left side of the interface (Figure 3.9).

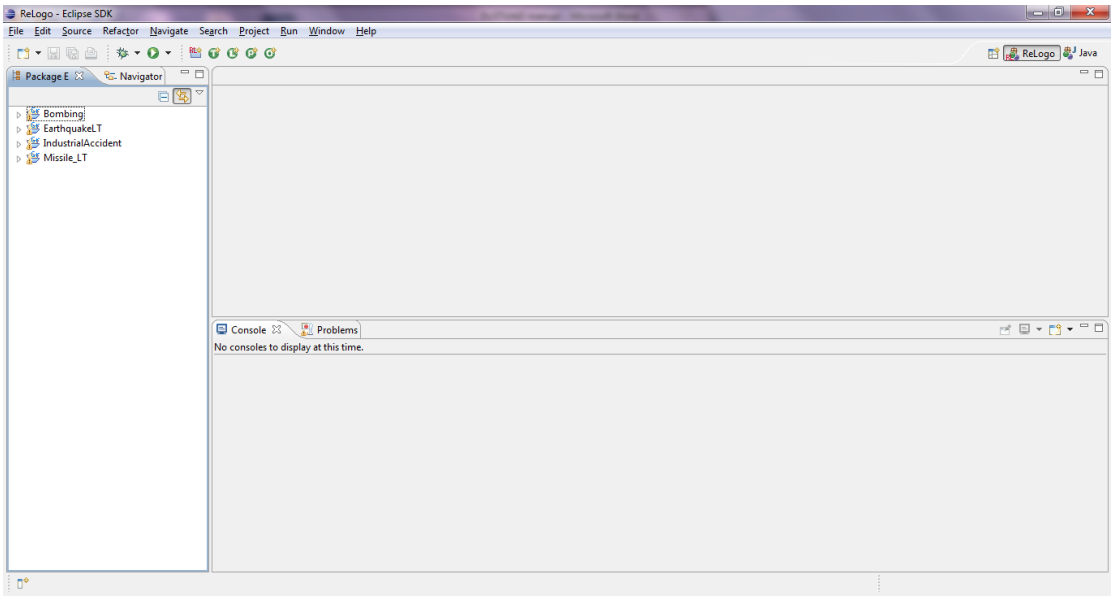


Figure 3.9. Eclipse SDK interface, including imported models.

XV. When expanding the folder of each of the models, their contents can be viewed. Expand the 'src' folder, and then the folder bearing the model name (e.g. 'Bombing' for the bombing model) in order to view the source code of the model (Figure 3.10).

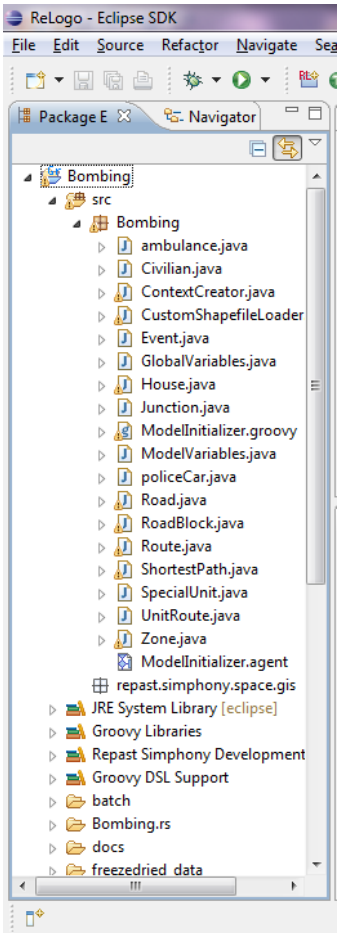


Figure 3.10. Navigating to the source code.

XVI. The code is organized into Classes. Some of them represent agents in the model and methods related to them (such as Civilian). Others are used to represent more abstract elements (such as the ContextCreator class) or even just to store variables (such as GlobalVariables or ModelVariables). By double clicking one of the classes, their content appears on the upper left quadrant of the interface (Figure 3.11). This is required in order to characterize the specific environment and scenario you wish to simulate.

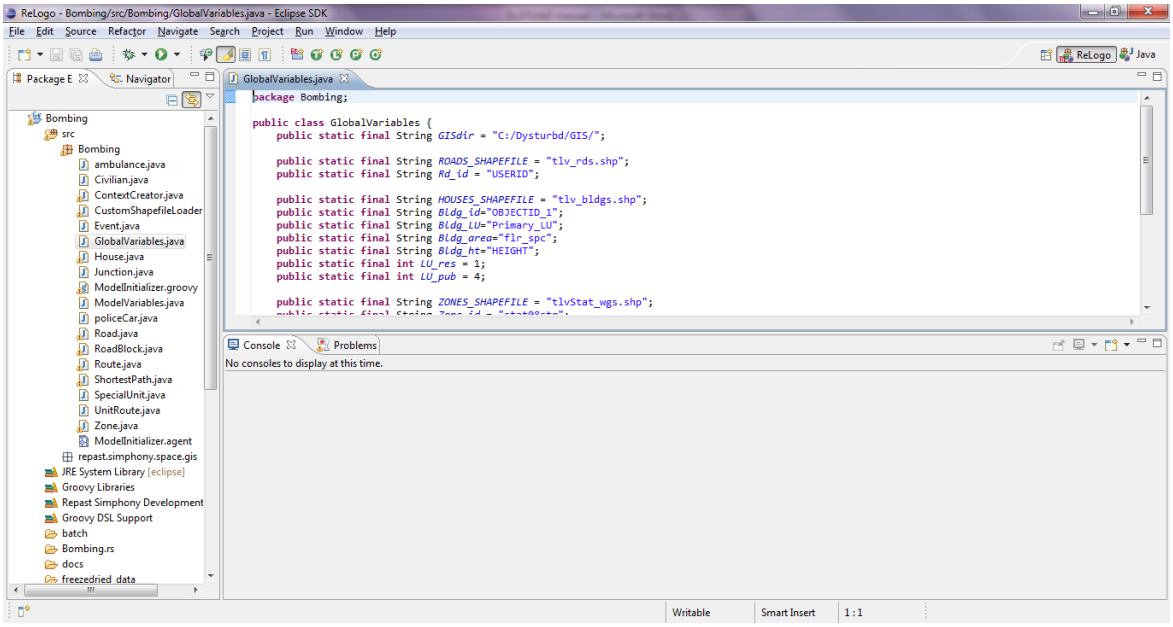


Figure 3.11. The contents of the GlobalVraibles Class.

XVII. To run the model, press the small downward-facing arrow near the 'Run As…' green 'play' icon. On first use, no process is defined here. Choose 'Run Configurations…' in order to define one (Figure 3.12).

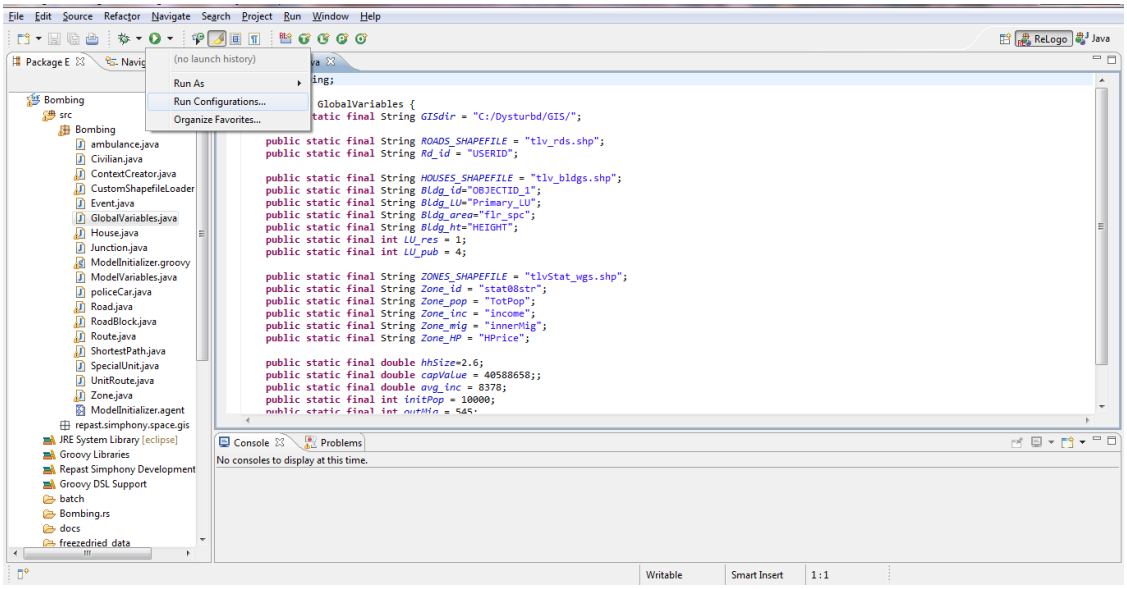


Figure 3.12. Running a model.

XVIII. Expand the options under 'Java Application' on the left side of the 'Run Configurations' screen. Choose the option carrying the name of the model (e.g. 'Bombing', with no 'Batch' or 'Build Installer' before it), and press Run (Figure 3.13). This option is now available under the 'Run As...' menu for this workspace from now on.

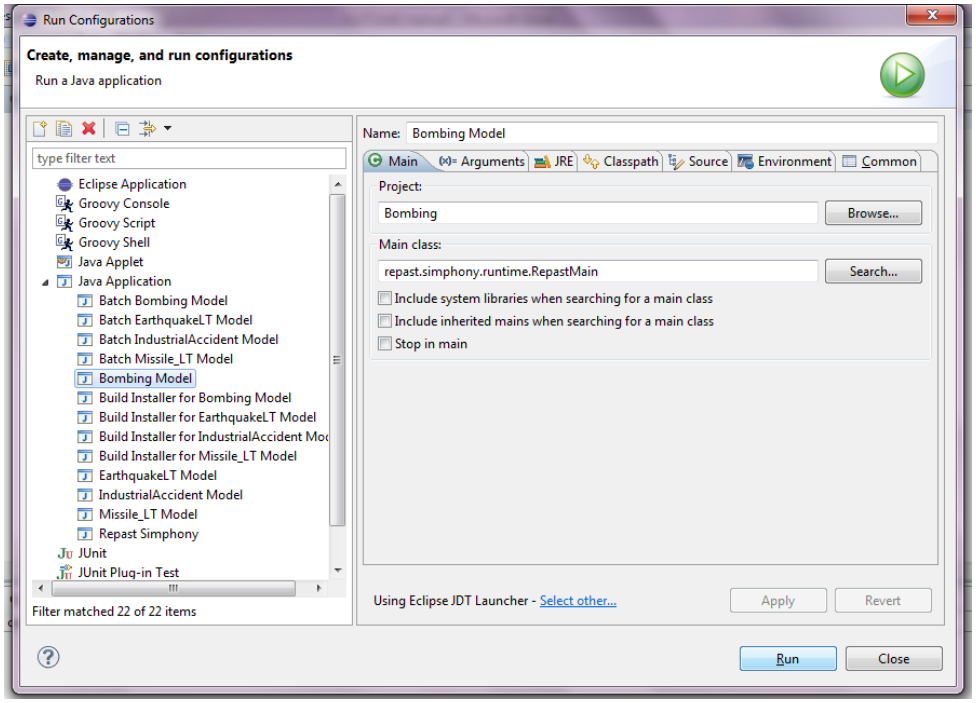


Figure 3.13. Selecting a model to run.

XIX. Upon completing the previous stage, a new 'simulation screen' interface would load. In order to start and run the simulation, press the ‘Start’ button (Blue ‘play’ icon on the upper part of the screen; Figure 3.14).

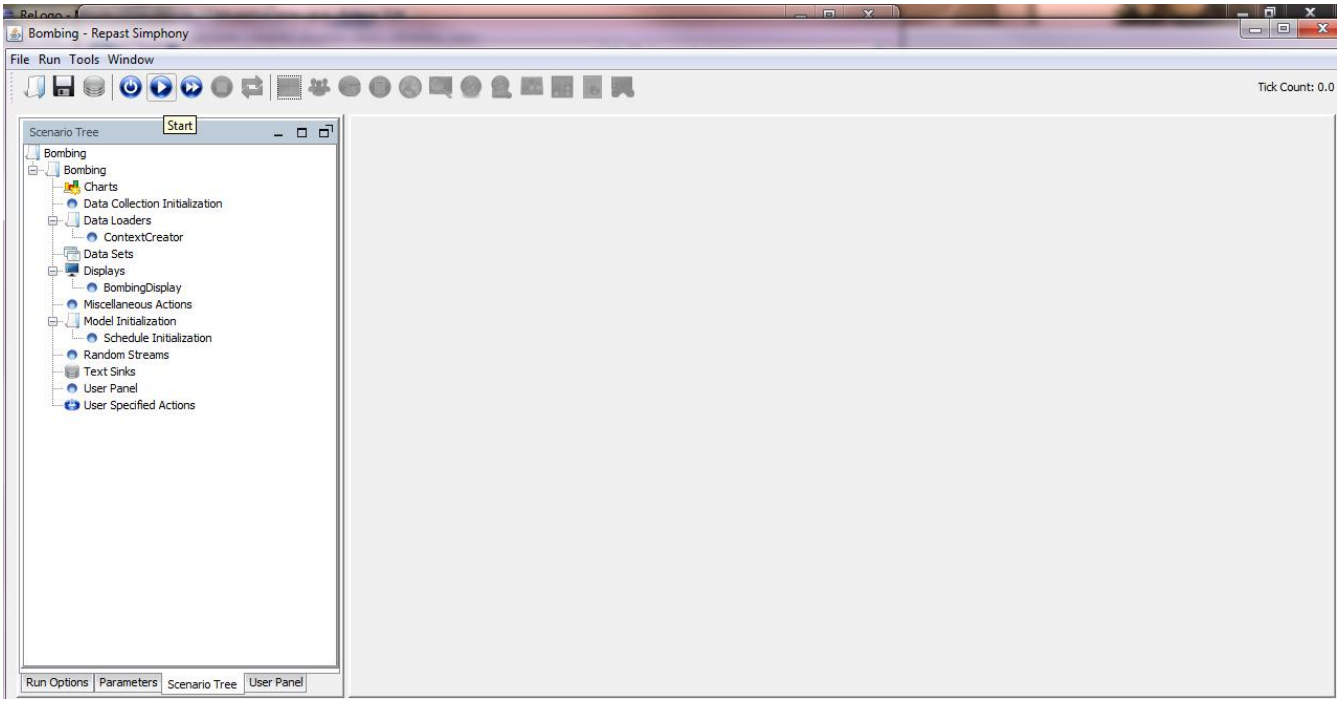


Figure 3.14. Simulation screen.

XX. During the simulation, visual outputs are presented on the right side of the simulation screen (Figure 3.15). Textual documentation of is presented at the lower right quadrant of the interface (Figure 3.16).

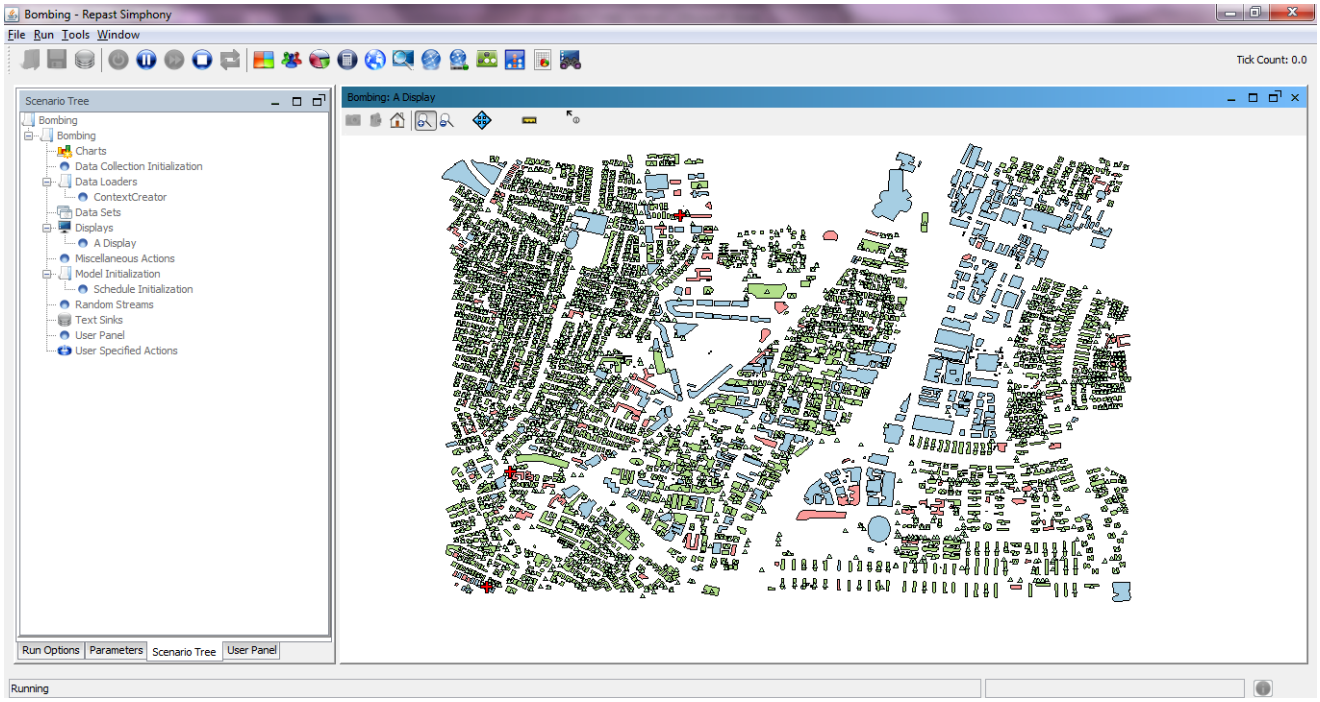


Figure 3.15. Cartographic outputs during simulation.

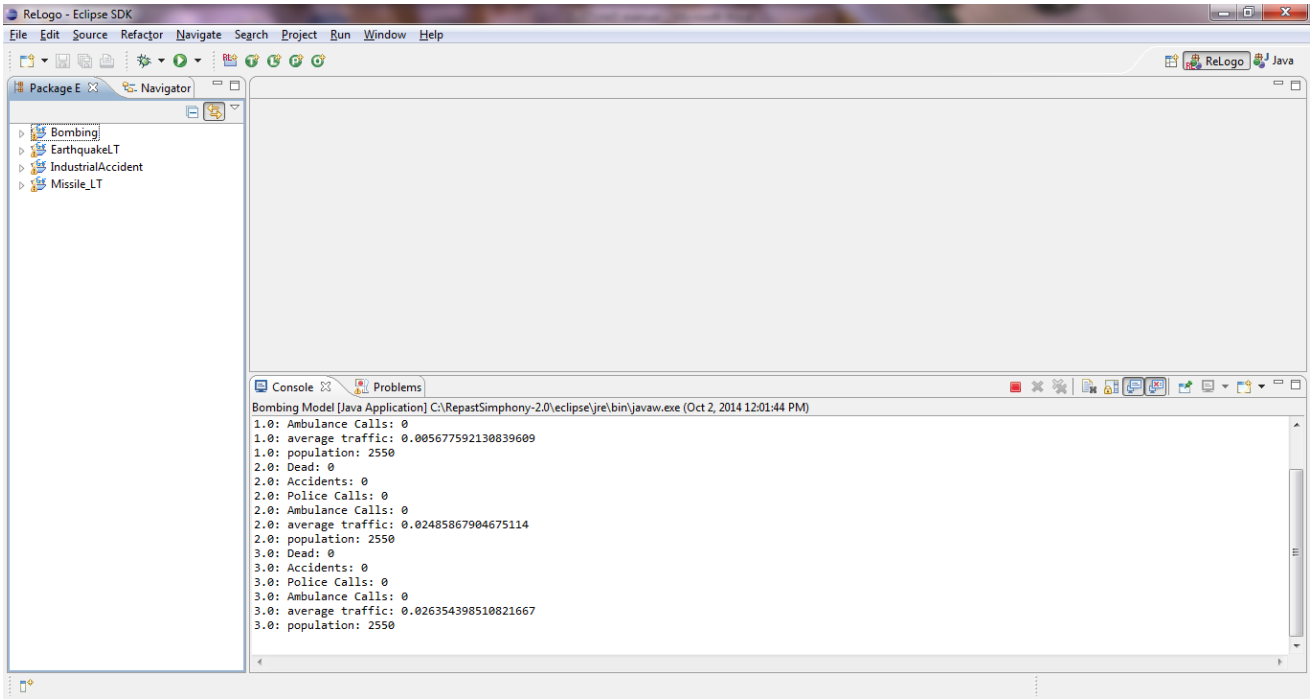


Figure 3.16. Textual output during simulation run.

4. SensoMeter (HUJI)

The background and DESURBS advances for the SensoMeter smartphone application for crowd control surveys are reported in Deliverable 4.5.

Part A: The Web Application (for administrator users)

4.1.1. Functionality of the SensoMeter Web Application

The web application was designed to allow administrator users to configure their campaign. The web application can be accessed from any computer that has an Internet connection and an Internet browser and it allows administrator users to:

1. Configure surveys and surveys' triggers (including polygons that define the spatial area of a survey)

2. Configure various system properties (including communication, battery usage sample rate etc.)

3. Manage mobile users

4. View location data in real time

5. Export data

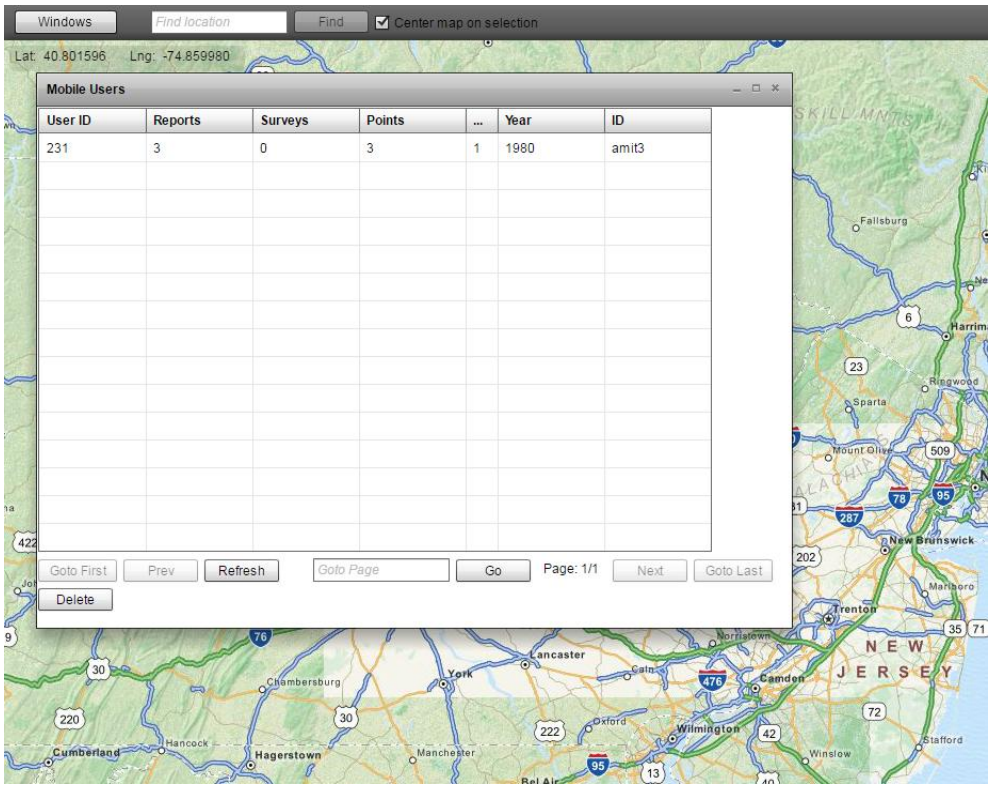
6. Send and receive messages to/from a specific user or group of users

4.1.2. Web Application Windows

The web application includes 8 main windows that can be accessed from the top left hand part of the main screen: 'Mobile Users', Polygons', 'Surveys', 'Poly-Surveys', 'Configuration', Reports', 'Survey Results', and 'Messages'.

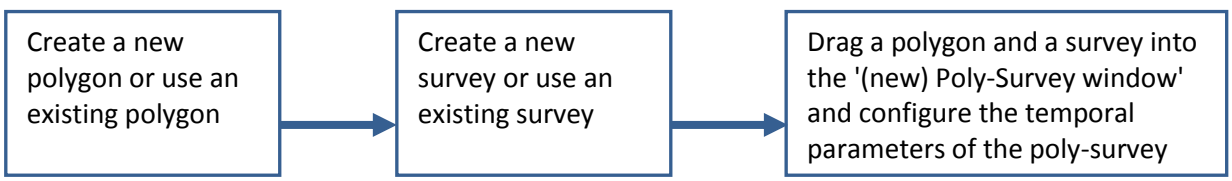
4.1.2.1 Mobile Users Window

The 'Mobile Users' screen allows the administrator to observe the mobile users that downloaded the mobile application and that are registered for the campaign of the administrator's client.



Configuring a Survey: The Polygon, Survey and Poly-Survey Windows

The Polygon, Survey and Poly-Surveys windows allow the administrator user to configure location-based surveys. In order to generate a survey that will be triggered in the mobile application the administrator user is required to activate a poly-survey. The following flow chart describes the stages of creating a Poly-Survey.


Create a new polygon or use an existing polygon
Create a new survey or use an existing survey
Drag a polygon and a survey into the '(new) Poly-Survey window' and configure the temporal parameters of the poly-survey

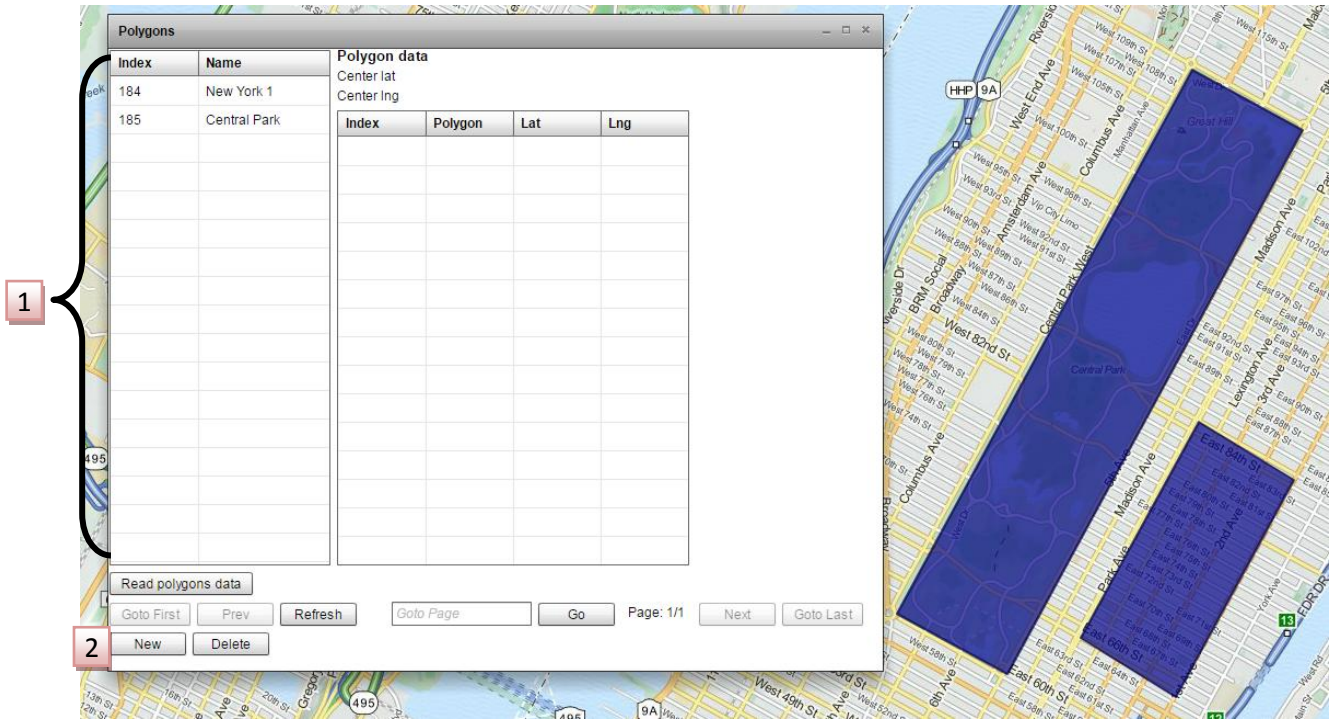
4.1.2.2 The Polygon Window (observing existing polygons and creating new polygons)

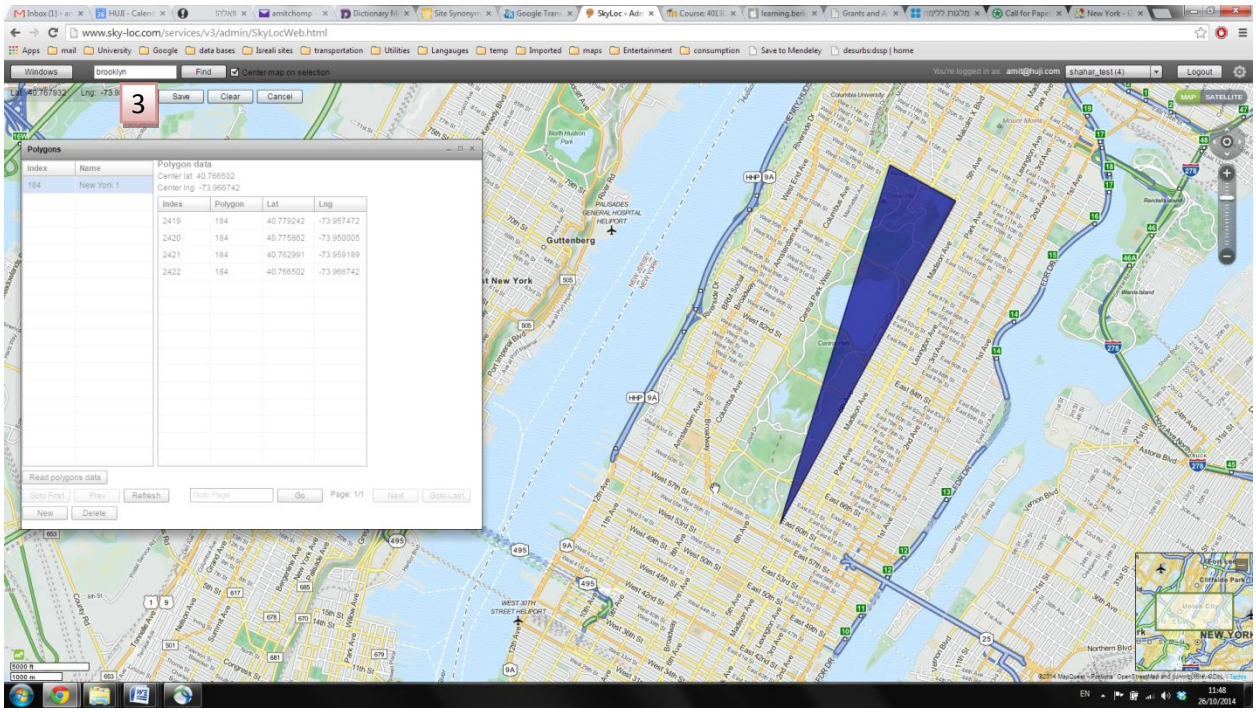
The polygon window allows the administrator user to observe existing polygons that were defined in the past and to generate new polygons by drawing them on the map.

1) A list of existing polygons – when selecting an item on the list the map will zoom to the selected polygon.

2) Create a 'New' polygon button – after pressing this button you will be requested to draw a polygon on the map.

3) Save polygon – after you finish drawing a polygon you will be required to save it by pressing the save button and giving the polygon a name (see next image).



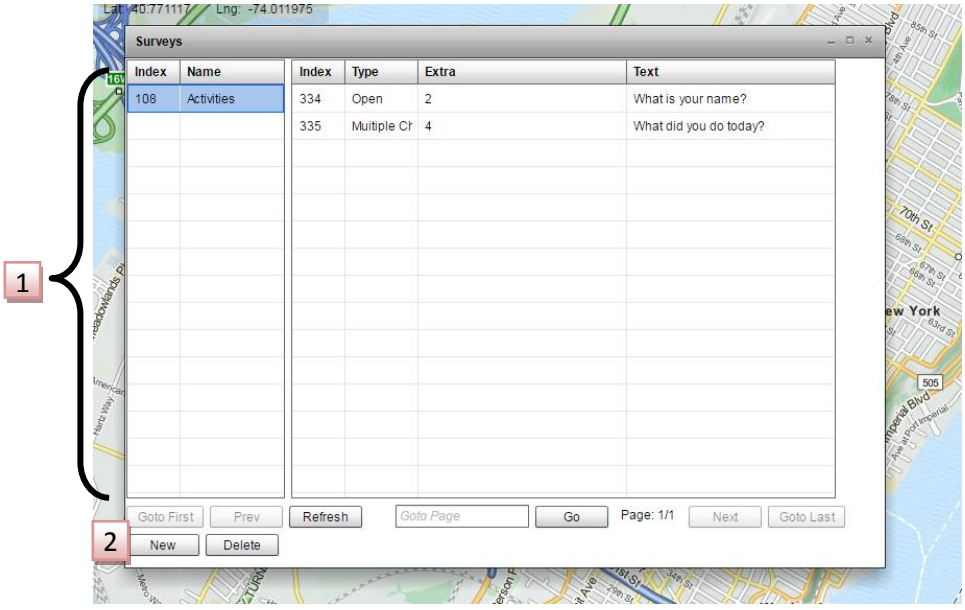


4.1.2.3 The Surveys Window (observing existing surveys and creating new surveys)

The surveys window allows the administrator user to observe existing surveys that were defined in the past and to generate new surveys by creating new questions.

1) A list of existing surveys.

2) Create a 'New' survey button – after pressing this button you will be requested to create a new survey. The new survey window will be opened.



New Survey Window

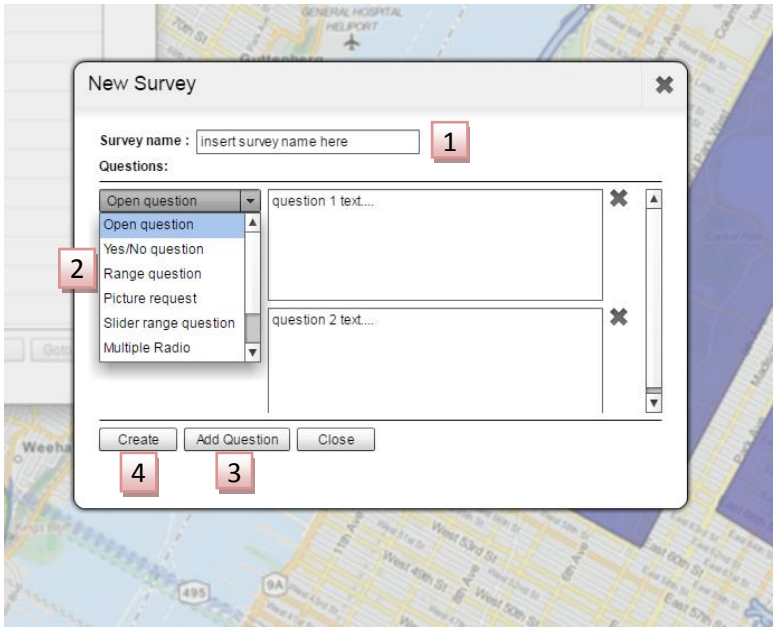
The new survey window allows you to compose questions for your new survey. Use the following buttons and controllers to generate the new survey

1) Survey name – insert the survey name here (you cannot save the survey without assigning the survey a name).

2) Type of question – this controller allows you to choose the type of question

3) Add Question – this button allows you to add a new question to the survey

4) Create – press this button when you finish creating the survey (you are required to give the survey a name before saving it). This button will save the survey and add it to the list of existing surveys.



4.1.2.4 The Poly-Surveys Window

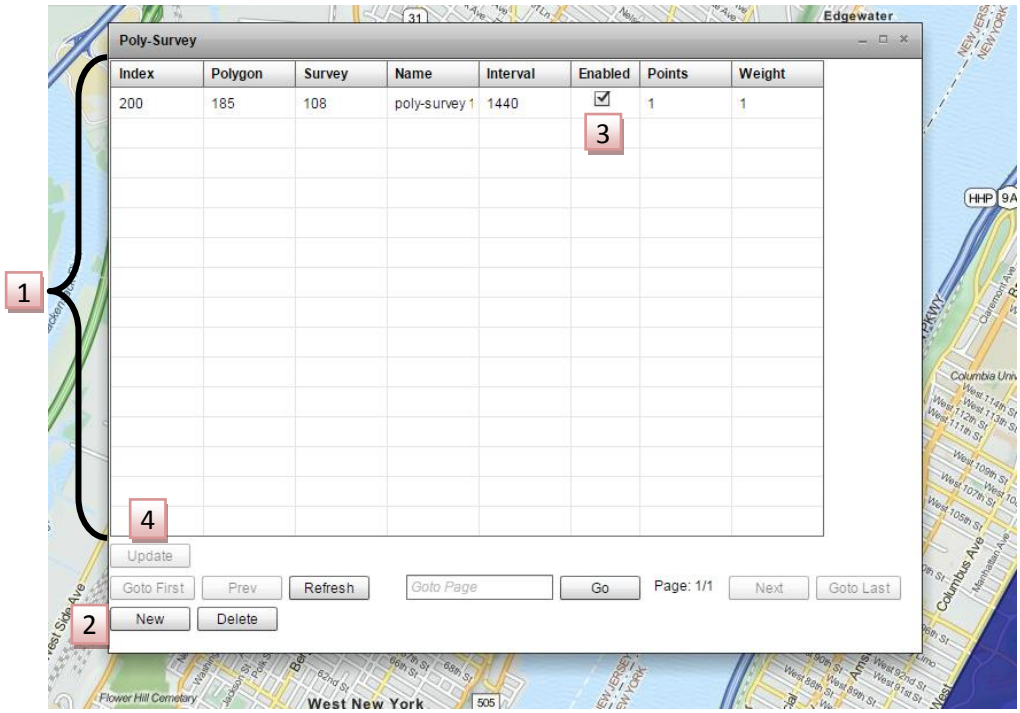
In order to activate a survey and define its triggering parameters, the administrator user must use the Poly-Surveys Window. Use the following buttons and controllers in order to activate a (poly)-survey.

1) A list of existing poly-surveys.

2) Create a new poly-survey button – after pressing this button you will be requested to create a new poly-survey. The new poly-survey window will be opened.

3) Enable poly-survey – check / uncheck the box in order to enable / disable a poly-survey. Press the Update button (in the bottom) in order to put the disable / enable into action.

4) Update – press this button after checking / un-checking the Enable box in order to enable / disable a survey.



New Poly-Survey Window

The new poly-survey window allows you to create a new poly-survey. This is the way you can activate and configure your surveys. Use the following buttons and controllers to generate the new poly-survey

1) Poly-Survey name – insert the poly-survey name here (you cannot save the poly-survey without assigning it a name).

2) Points – insert the number of points that a mobile user will receive when completing this poly-survey (this is used as an incentive for mobile users)

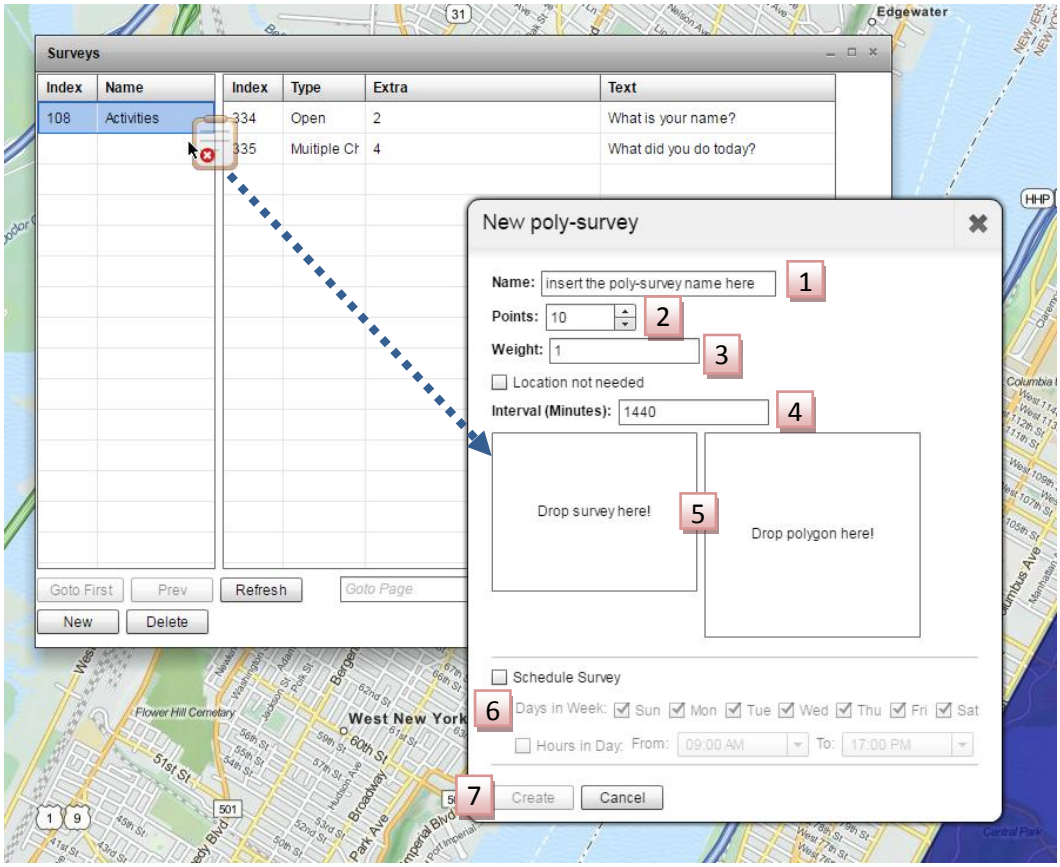
3) Weight – this controller defines the probability of a poly-survey to be triggered each time the mobile application is checking for new available survey (1=100%, 0.5=50%). The poly-survey can only be triggered when the temporal and spatial conditions are met (i.e. the mobile phone is within the polygon and within the time frame that was defined).

4) Interval (Minutes) – this controller defines the minimum interval between each two poly surveys

5) Drop survey here and Drop polygon here boxes – Drag a survey from the surveys window and (optionally) a polygon from the polygons window into these boxes in order to activate a survey and to associate between a survey and a polygon.

6) Schedule Survey – this group of controllers allows defining the time frame within which the poly-survey can be triggered (e.g. Sundays and Mondays between 8:00-12:00)

7) Create – press this button when you finish creating the poly-survey (you are required to give the poly-survey a name before saving it). This button will save the poly-survey and add it to the list of existing poly-surveys.



* Configure a Poly-Survey without spatial parameters (without a polygon)

Check the 'Location not needed' box in order to configure a survey that is triggered based on temporal parameters only. When the 'Location not needed' box is checked, you are not required to drag a polygon into the '(new) Poly-Survey' window.

4.1.2.5 Configuration Window

The configuration window allows you to define the structured reports that will appear at the mobile applications of your mobile users, and to control several different settings.

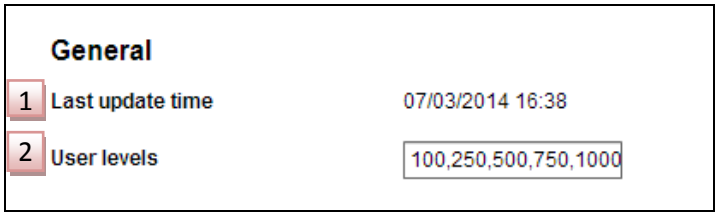
- After changing the settings you are required to press the update button at the bottom of the configuration window.
-

General Settings

General settings allows you to:

1) Show the last update time – see when was the last time in which the settings had been updated.

2) Define User levels - define the number of points that a mobile user should gain for advancing in the various levels (this is used as an incentive for mobile users who may gain points for each survey or report that they complete).



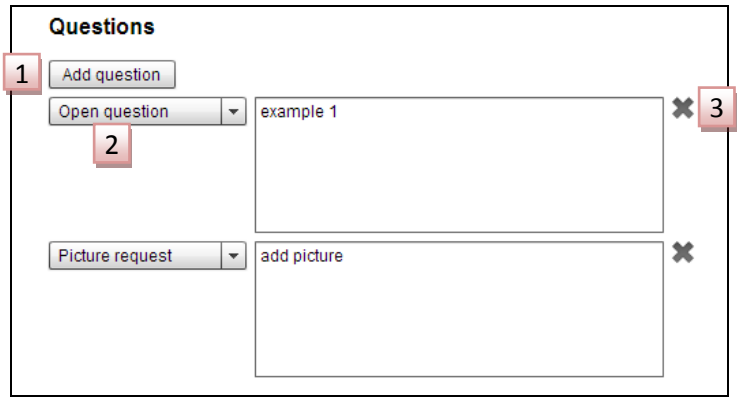
Questions Settings

The questions controllers allow you to define and add questions to the structured reports that appear in the mobile application (see part B of this manual):

1) Add a question to the report

2) Choose the type of question

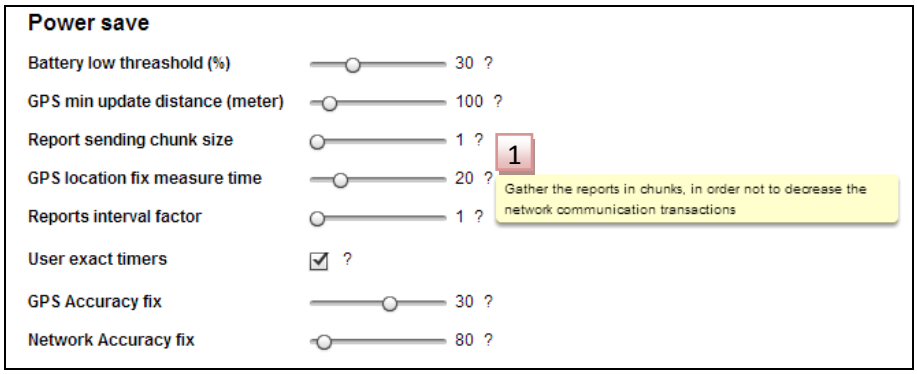
3) Remove a question



Power save Settings

The power save settings allow you to control the battery usage of the phone where usually there is a tradeoff between location accuracy and battery usage.

1) Standing on the question mark symbol with the mouse crosser opens a text box that explains how the controller next to the symbol influences the battery usage of the mobile phone.



Surveys and Reports Settings

The surveys and reports settings allow the administrator user to configure the reports and surveys of the phone

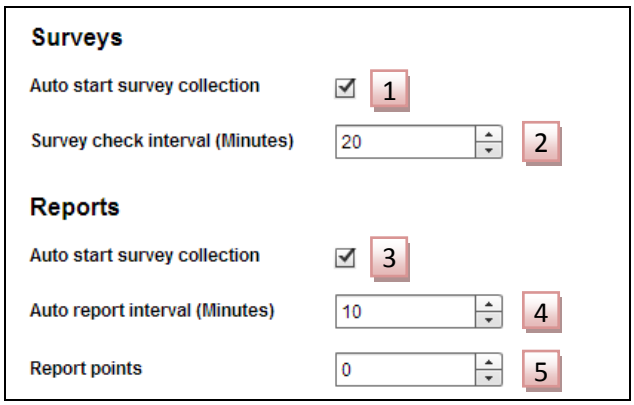
1) Auto start survey collection – when this box is checked the mobile application will automatically start looking for available surveys after the application is downloaded and activated.

2) Survey check interval (Minutes) – determines how often the mobile application will look for available surveys (this influences the battery usage).

3) Auto start reports collection - when this box is checked the mobile application will automatically start recording phone location (in the interval that is specified bellow) after the application is downloaded and activated.

4) Auto report interval (Minutes) – defines the interval of location recording.

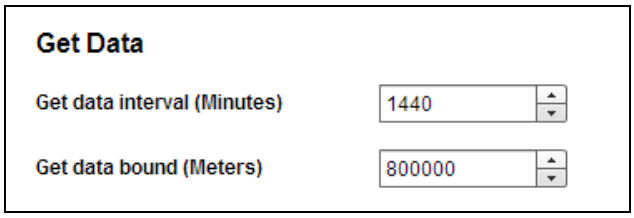
5) Report points – defines how many points the mobile will receive for each report that he/she sends.



Get Data Settings

1) Get data interval (Minutes) – defines how often the mobile application will contact the server in order to be updated with new surveys and new settings.

2) Get data bound (Meters) – Only (poly)-surveys that fall within the radius that is defined here will be uploaded to the mobile app. This applies only for (poly)-surveys that include a geographical conditioning (have a polygon assigned to them).



4.1.2.6 Reports Window

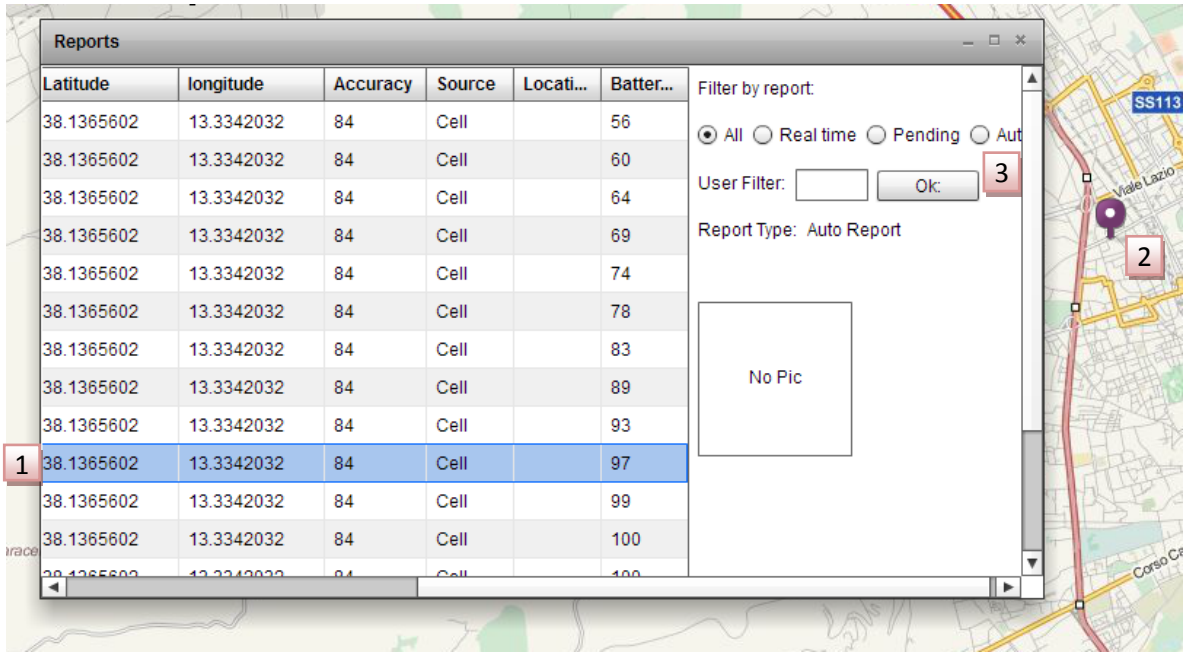
In the reports window you can observe the location of reports and some metadata information about the reports. There are two types of reports. Auto reports are automatic location reports that are sent by the mobile application based on the configurations that were defined by the administrator user (see configuration window). Real time and Pending reports are structured reports that were initiated by the mobile user (see part B of this manual about the mobile application).

Use the following controllers to navigate within the Reports window

1) List of reports – choose a report to see its location on the map

2) Report location – after choosing a report you can see its location on the map (marked with a purple pin)

3) Filter reports – you may filter reports based on the user id and type of reports.



4.1.2.7 Surveys Results window

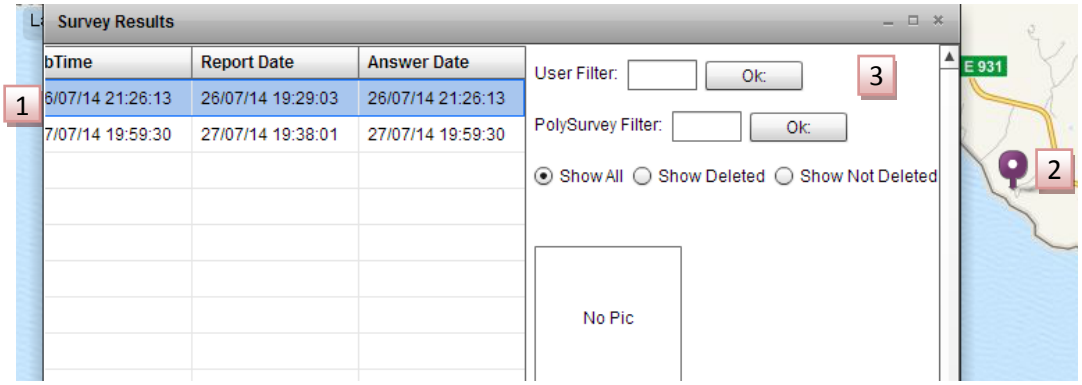
In the Survey results window you can observe the location of Surveys and some metadata about the Surveys.

Use the following controllers to navigate within the Surveys Results window

1) List of Surveys – choose a report to see its location on the map

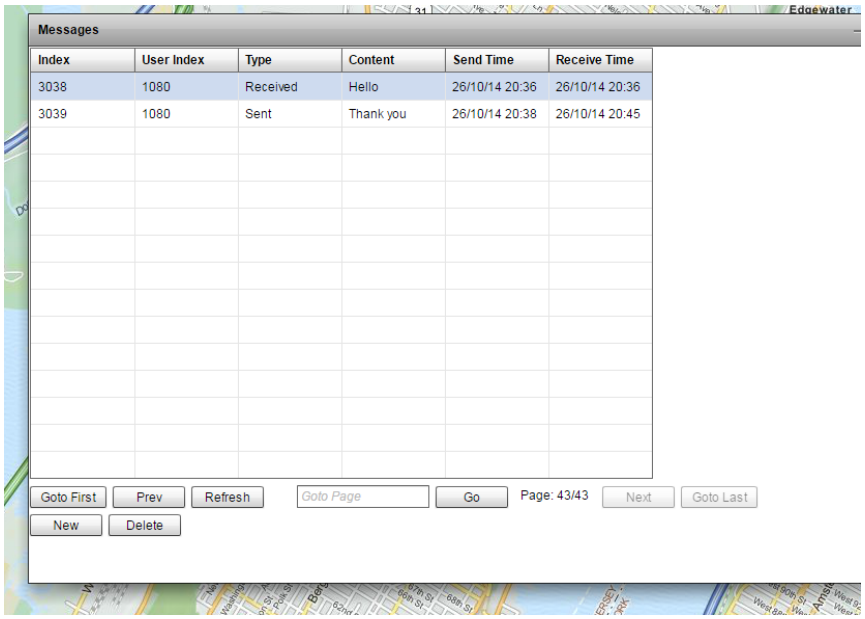
2) Survey location – after choosing a Survey you can see its location on the map (marked with a purple pin)

3) Filter Surveys – you may filter reports based on the user id and/or the poly-survey id.



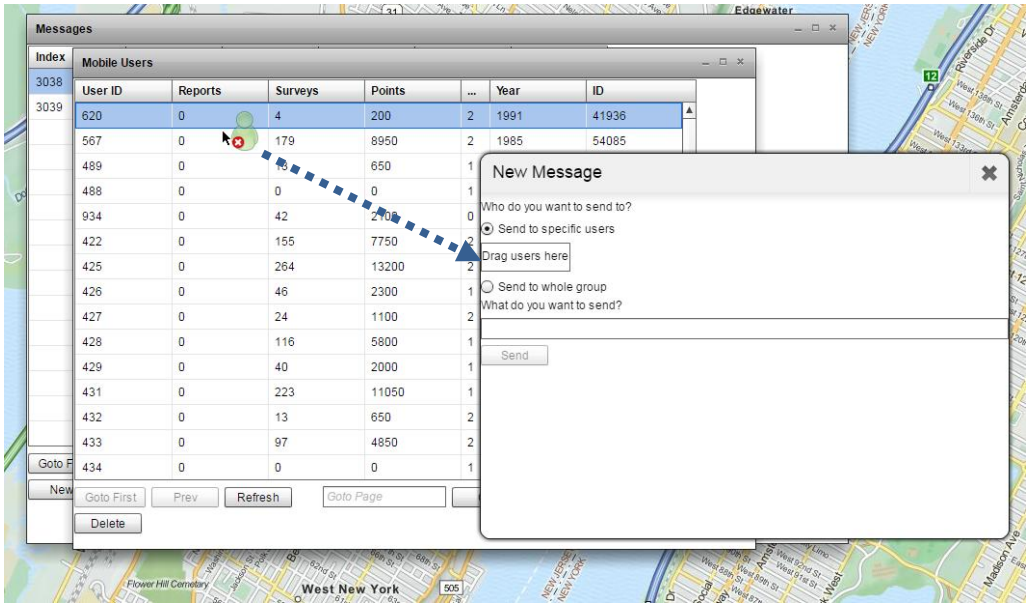
4.1.2.8 Messages Window

The messages window allows the administrator user to communicate with the mobile users through text messages. Press the 'New' button in order to send a new text message to the entire group or to a specific mobile user. Alternatively, double click a message in order to reply to a mobile user.



New message window

In order to write a message to a mobile user, drag a mobile user from the 'Mobile Users' window into the New Message window. Afterwards type the message that you would like to send in the box bellow. In order to write a message to the entire group check the 'send to whole group' option.



4.2 Part B: The Mobile Application

4.2.1 Functionality of the SensoMeter Mobile Application

The SensoMeter application is a location based survey system which allow its users to:

1. Receive surveys based on location and/or predefined schedule.

2. Initiate structured reports that include geographical references.

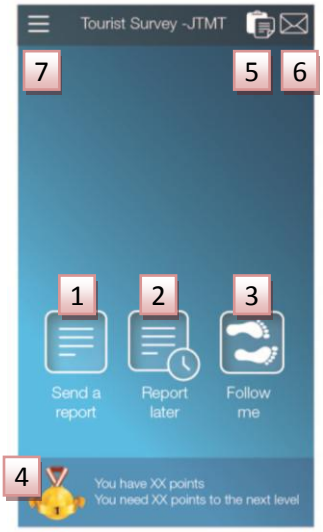
3. Send automatic reports about the location of the user ('follow me' reports).

4. Send and receive text messages to/from the survey manager.

4.2.2. Mobile Application Screens

4.2.2.1 Main Screen

The main screen of the application includes 3 main buttons (1, 2, 3), a status bar (4), notification icons about new surveys (5) and new messages (6) and a menu button (7).



(1) Pressing the "Send a report" button will open the Real time report screen (see explanation bellow) which lets you send a structured report.

(2) Pressing the "Report later" button generates a new report that includes your current geographical location. The report can be accessed and completed at a later time through the Pending report screen. The report later button is useful when you cannot complete a report about a specific location, and wish to report about it later on.

(3) Pressing the 'Follow me' button turns off/on the follow me reports option. 'Follow me' reports are automatically-generated reports that include the geographical location of the phone. The interval of the reports is defined by the survey manager. When the Follow me report is on (white color), the

phone sends location reports automatically and a notification (two footsteps) will appear at the notification bar of the phone.

(4) The status bar shows you your current level, the number of points you have collected so far (by completing surveys and sending reports), and the number of points you need to collect for the next level. Pressing the status bar will open a detailed status screen (see below).

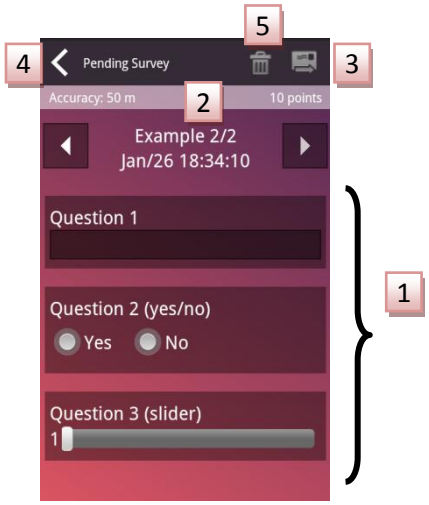
(5) Survey notification – this notification indicates that you have a pending survey that should be completed. Pressing the survey notification will open the survey itself. By completing the survey you can earn points and advance in levels.

(6) Message notification – the message notification indicates that you received a new message from the survey manager. Pressing the message notification will open the messaging screen (see below).

(7) Menu – pressing the menu button will open the menu of the application. The menu allows you to control the settings, enter the messaging screen, and complete pending surveys and pending reports.

4.2.2.2 Pending surveys screen

Whenever you receive a new survey, a notification icon (followed by a notification sound) will appear at the notification bar of your phone and in the main screen of the application. Press the icon in order to complete the survey/s



(1) The survey – complete it using the touch screen and keyboard. This part of the screen can be scrolled up and down.

(2) Survey information bar – the bar includes (a) the geographical accuracy level that is available; the higher the number the less accurate will be the location of the report*. (b) The number of points that you gain for completing and sending the report.

**You can improve the accuracy level by activating the phone's GPS and Wi-Fi. If you are indoors, place the phone near a window where a satellite signal can be obtained.*

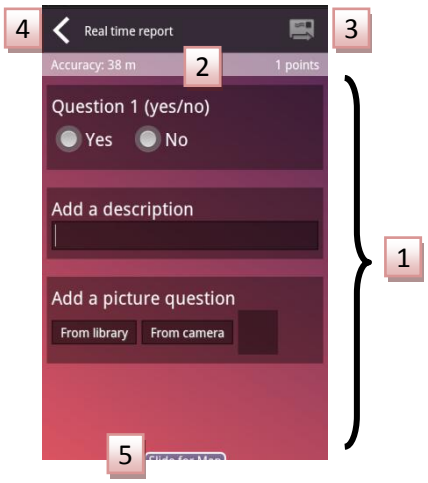
(3) Send button – Once you finish completing the report, press this button and the report will be delivered.

(4) Back to the main screen of the application

(5) Delete survey button.

4.2.2.3 Real time report screen

The real time report screen allows you to send a structured report in real time by pressing the: 'Send a report' button that is located in the main screen.



(1) The report – complete it using the touch screen and keyboard. This part of the screen can be scrolled up and down.

(2) Report information bar – the bar includes (a) the geographical accuracy level that is available; the higher the number the less accurate will be the location of the report*. (b) The number of points that you receive for completing and sending the report.

**You can improve the accuracy level by activating the phone's GPS and Wi-Fi. If you are indoors, place the phone near a window where a satellite signal can be obtained.*

(3) Send button – Once you finish completing the report, press this button and the report will be delivered.

(4) Back to the main screen of the application

(5) Slide for map button – scroll this button up if you wish to pinpoint your location manually (when the accuracy level is low). The button will open a map on which you can pinpoint your location.

4.2.2.4 Pending report screen

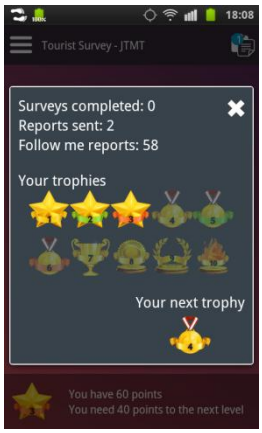
The Pending report screen allows you to complete a report that you initiated using the Report later button that is located in the main screen. Pending reports include the location and time that were recorded at the moment that you pressed the report later button.

Pending reports can be completed the same way as real time reports (see 2.3)

4.2.2.5 Status screen

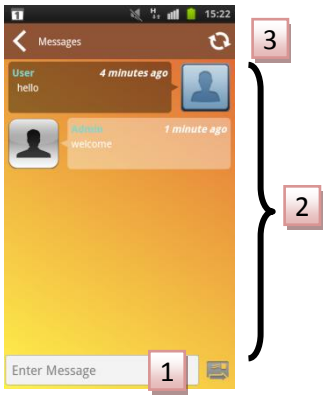
The status screen includes information about the number of points that you gained and the number of surveys and reports that you have already completed. In addition, it presents the trophies that you

have collected. You can view the status screen by pressing the status bar that is located on the bottom of the main screen of the application.



4.2.2.6 Messaging screen

Through the messaging screen you can read text messages that were sent to you by the system admin and send back a reply. Whenever you receive a new message, an envelope notification will appear at the notification bar of the phone and at the main screen of the application.



(1) Message box – press the box in order to type a message. To complete the action, press the send button that is next to it.

(2) The content of the messages.

(3) Refresh button – press it to receive new messages.

5. STREMA-DB & FCMODEL(TUC)

A description of the use lf the web application for the STREMA-DB Strength of materials database is given in chapeter 2 &3 of D4.6 'Materials database/numerical modeling'. Here we provide the user manual for the FCMODEL part of the TUC package.

FCMODEL Usage Manual and Documentation

FCMODEL is a MATALB™ application that calibrates failure criteria. The application provides several built-in failure criteria that can be calibrated on experimental data. The user may also import additional failure criteria into the application.

Prerequisites

The FCMODEL application has been developed in MATLAB 7.12.0 (R2011a) with Optimization Toolbox. Thus, for MATLAB's versions R2011a and later, it will execute as expected. The Optimization Toolbox must also be installed. The FCMODEL application may even run in older versions of MATLAB but its behavior cannot be guaranteed.

Installation

To install the FCMODEL application:

1. Extract the zipped folder in your hard disk (the file can be obtained from George Exakaktylos at DESURBS partner TUC)
2. Open MATLAB
3. Select *File* → *Set Path…*
4. Click *Add with subfolders…*
5. Select the extracted *fcmodel* directory in your disk
6. Click *Save*
7. Click *Close*

The FCMODEL application is now installed in your system. For more details on setting the path, please consult MATLAB's documentation.

Background Theory: Conventions, Definitions and Minimization Algorithm

Conventions

The FCMODEL application assumes tension positive and compression negative. Moreover it assumes

$$\sigma_1 \geq \sigma_2 \geq \sigma_3 \qquad (1)$$

where σ_1 , σ_2 and σ_3 are the three principal stresses of the Cauchy stress tensor σ_{ij}.

Definitions

The FCMODEL application requires the failure criteria to be given as expressions of the octahedral stresses and the Lode angle. Every failure criterion must be given in the form

$$T = f(p, \theta) \tag{2}$$

where

$$p = \frac{1}{3} I_1 = \frac{1}{3} \sigma_{kk} = \frac{1}{3} (\sigma_1 + \sigma_2 + \sigma_3) \tag{3}$$

is the mean pressure or octahedral normal stress and I_1 is the first invariant of the Cauchy stress tensor σ_{ij}. T is the octahedral shear stress

$$T = \sqrt{\frac{2}{3} J_2} \tag{4}$$

and the Lode angle θ is given by

$$cos3\theta = \frac{3\sqrt{3}}{2} \frac{J_3}{J_2^{3/2}} \tag{5}$$

where J_2 and J_3 are the second and third invariants of the stress deviator tensor s_{ij}, respectively.

$$\sigma_{ij} = p\delta_{ij} + s_{ij} \tag{6}$$

$$J_2 = \frac{1}{2} s_{ij} s_{ji} \tag{7}$$

$$J_3 = \frac{1}{3} s_{ij} s_{jk} s_{ki} \tag{8}$$

where δ_{ij} is the Kronecker Delta.

Minimization Algorithm

FCMODEL utilizes the non-linear trust region reflective algorithm to calibrate the failure criteria. Firstly, every experimental point is converted to its corresponding (p, T, θ) cylindrical coordinates. Then, the non-linear least squares algorithm tries to minimize the Sum of the Squared Residuals (SSR) by altering the parameters of the failure criterion. The objective function subject to minimization is given by

$$SSR = \sum_{i=1}^{n} \left(T_i^{(\exp)} - T_i^{(\text{model})} \right)^2, \quad i = 1,2, \dots, n \tag{9}$$

where $T_i^{(\exp)}$ is the i-th experimental octahedral shear stress and $T_i^{(\text{model})}$ is the octahedral shear stress predicted by the failure criterion as calculated by Eq. (2). The mean pressure p and the Lode angle θ in Eq. (2) are the $p_i^{(\exp)}, \theta_i^{(\exp)}$ derived by the i-th experimental point.

Bibliography

A detailed analysis on the calibration procedure as well as the definitions of the build-in failure criteria may be found in the following references:

1. Liolios, P. and Exadaktylos, G. A smooth hyperbolic failure criterion for cohesive-frictional materials. Int. J. Rock Mech. Min. Sci., 58:85-91, 2013.
2. Liolios P., Exadaktylos G. (2013), Comparison of a hyperbolic failure criterion with established failure criteria for cohesive-frictional materials, *International Journal of Rock Mechanics & Mining Sciences* **63**, 12–26.

FCMODEL Application Environment

To execute (run) the FCMODEL application go to MATLAB's command window, type: *fcmodel* and hit ENTER. The application's main window is illustrated in Figure 1.

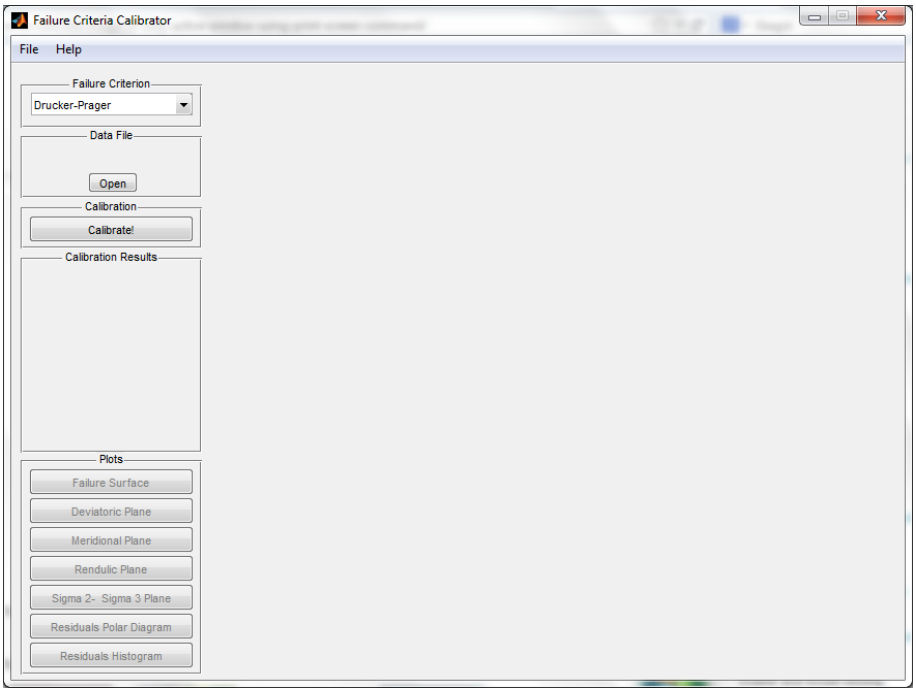


Figure 1: FCMODEL Application window

Failure Criterion Panel

The *Failure Criterion* drop down menu contains the available failure criteria (Figure 2). Any new failure criteria provided by the user will appear in this list.

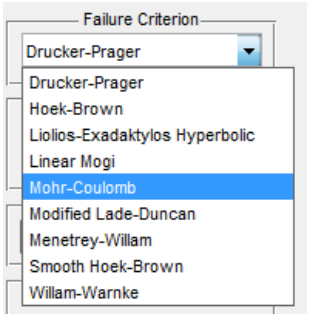


Figure 2: Failure Criterion drop down menu

Data File panel

The Data File panel is used to open the file that contains the experimental data (Figure 3). A data file must be selected before trying to calibrate.

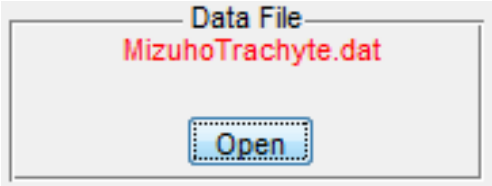


Figure 3: Data File panel

Data file structure and conventions

The data file must be in plain ASCII format (simple text file). Only .dat and .txt files are allowed. The file must contain three columns representing the three experimental principal stresses at failure. The three columns must be separated by the comma symbol ";". Each row in the file represents an experimental point. The first column represents the principal stress σ_1, the second column the principal stress σ_2 and the third the principal stress σ_3. The file must contain only the values of the experimental points and not any heading/tailing rows describing the columns etc.

According to FCMODEL's conventions, for example a Uniaxial Compression Strength (UCS) experiment would be written as

0;0;-σ

where -σ is the UCS value of the experiment (negative quantity). The subdirectory *data* in the *fcmodel* directory contains sample data files that can be used as reference.

Calibration panel

The *Calibrate!* button (Figure 4) calibrates the selected failure criterion on the experimental points. A data file must be set before executing the calibration.

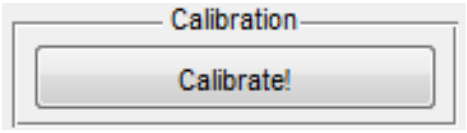


Figure 4: Calibration Panel

Calibration Results panel

The *Calibration Results* panel (Figure 5) displays the calibrated parameters after a successful calibration.

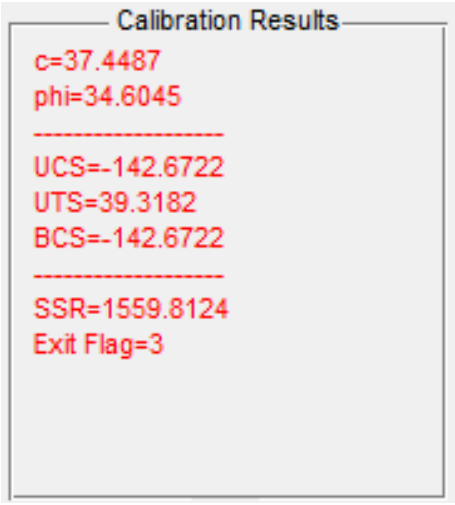


Figure 5: Calibration Results panel

The first group of numbers is the calibrated parameters of the selected model. The second group of numbers is the Uniaxial Compression Strength (UCS), the Uniaxial Tensile Strength (UTS) and the Biaxial Compression Strength (BCS) predicted by the calibrated model. The third group of numbers is the Sum of Squared Residuals (SSR) and the Exit Flag of the non-linear least squares trust region reflective algorithm. A good fit/calibration corresponds to low SSR value. FCMODEL uses MATLAB's *lsqcurvefit* algorithm to minimize the objective function. The possible Exit Flag values and their interpretation are the following:

1 Algorithm converged to a solution.

2 Change in failure criterion parameters too small.

3 Change in SSR too small.

4 Computed search direction too small.

0 Too many function evaluations or iterations.

-1 Stopped by output/plot function.

-2 Bounds are inconsistent.

-3 Regularization parameter too large (Levenberg-Marquardt).

-4 Line search failed.

For more detailed analysis on the Exit Flag, please consult MATLAB's documentation for the optimization function *lsqcurvefit.*

Plots panel

The plot options are available only after a successful calibration (Figure 6).

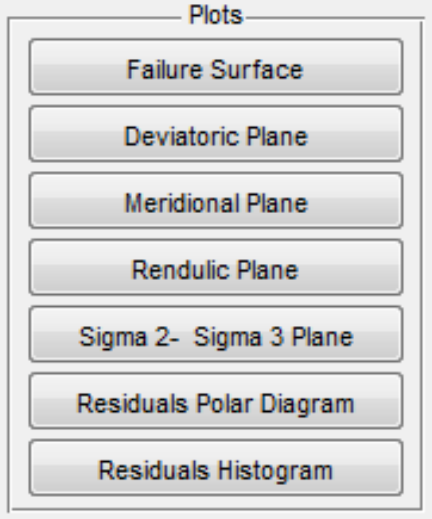


Figure 6: Plots panel

The application is able to plot the *Failure Surface*, the *Deviatoric Plane*, the *Meridional Plane*, the *Rendulic Plane*, the $\sigma_2 - \sigma_3$ *Plane*, the *Residuals Polar Diagram* and the *Residuals Histogram*.

Failure Surface

The *Failure Surface* option plots the calibrated failure surface as well as the experimental points (Figure 7).

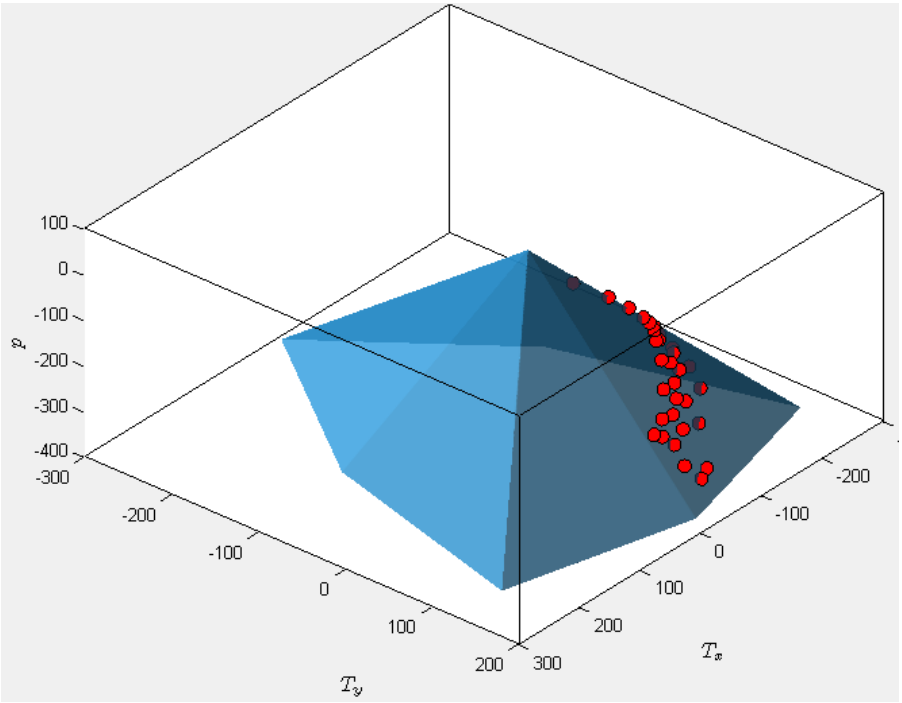


Figure 7: Failure Surface plot

Deviatoric Plane

The *Deviatoric Plane* option plots the traces of the failure surface on the deviatoric plane (Figure 8a). The plot illustrates the evolution of the shape of the failure surface with the increase of the mean pressure. Currently FCMODEL includes the failure criteria shown in Figure 8b.

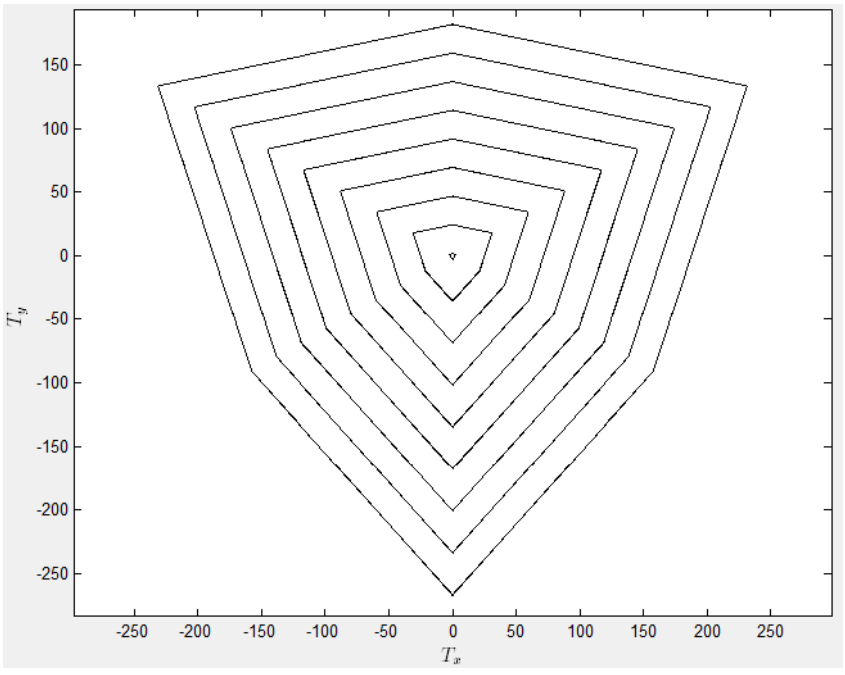


Figure 8a: Deviatoric Plane plot

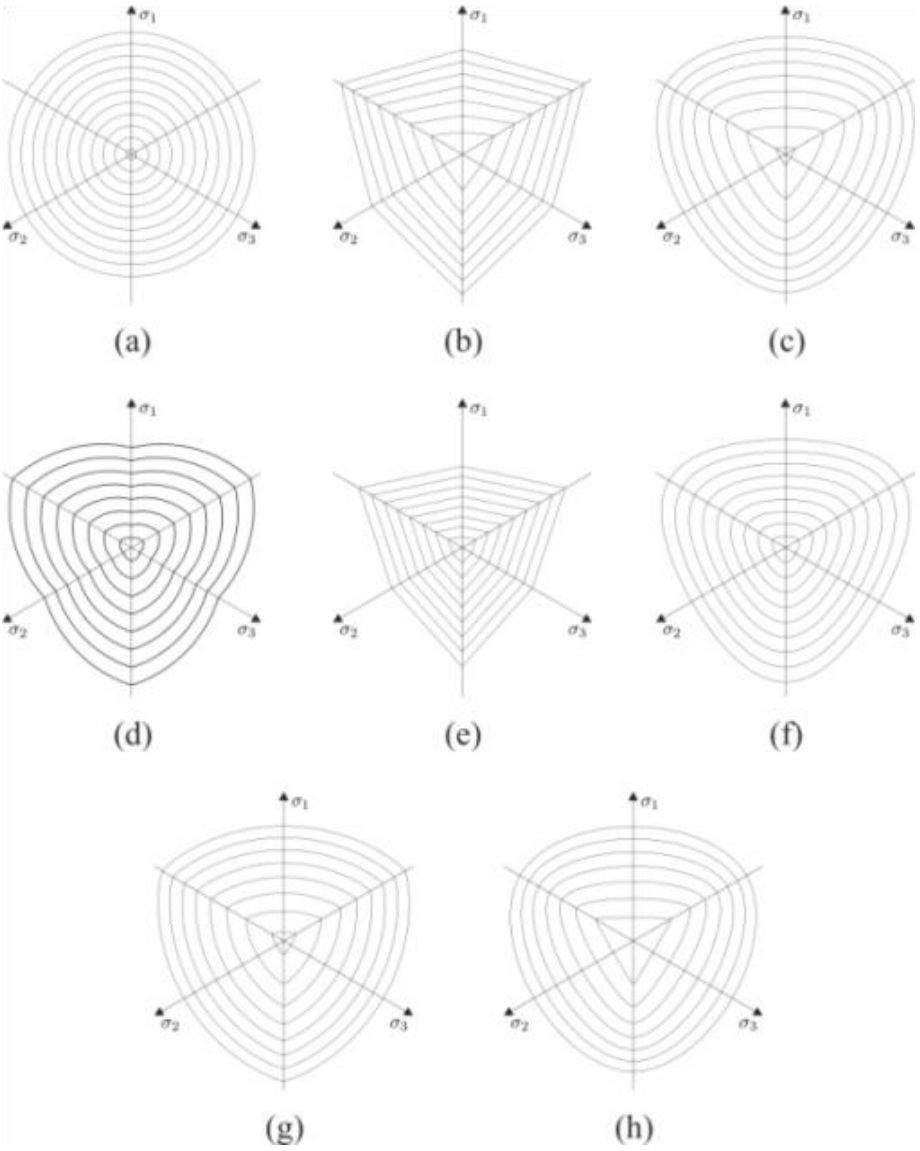


Figure 8b. Traces of failure models on the deviatoric plane: (a) Drucker-Prager, (b) Hoek-Brown,(c) Liolios-Exadaktylos, (d) Linear Mogi,(e) Mohr-Coulomb, (f) Modified Lade-Duncan (by Ewy),(g) Menetrey-Willam, and (h) Willam-Warnke.

Meridional Plane

The *Meridional Plane* option plots the compression ($\theta=60^{o}$) and the tensile meridian ($\theta=0^{o}$) of the calibrated failure criterion (Figure 9). It also plots any experimental points that lie on these two meridians.

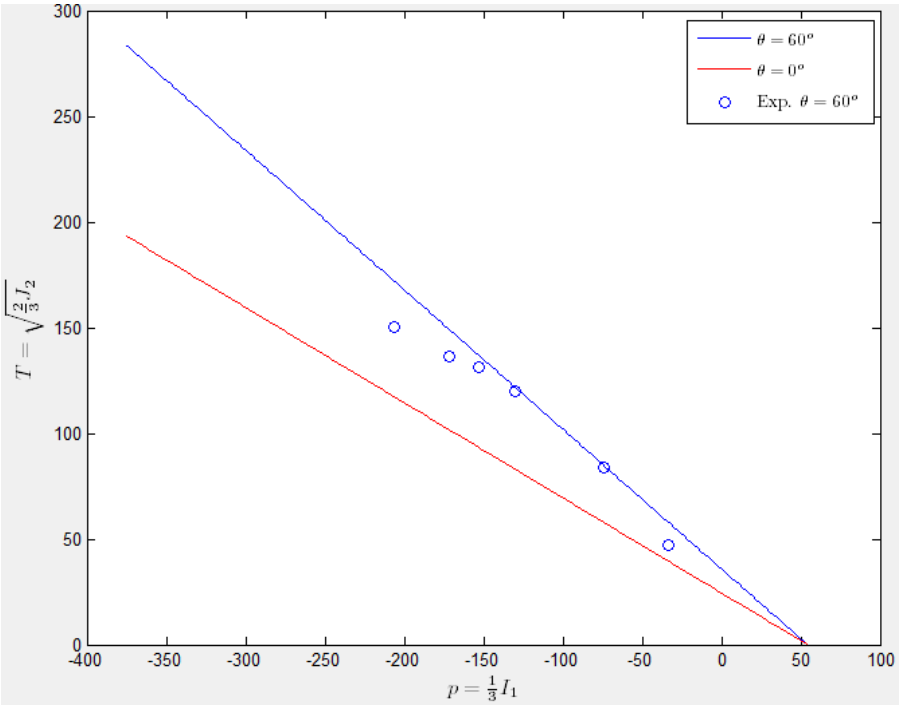


Figure 9: Meridional Plane plot

Rendulic Plane

The *Rendulic Plane* option plots the compression (θ=60°) and tensile (θ=0°) meridians of the calibrated failure criterion on the Rendulic Plane (Figure 10). The horizontal axis of the Rendulic plane is $\sigma_h = \sqrt{2}\sigma_1,\ (\sigma_1 = \sigma_2)$ and the vertical axis is $\sigma_v = \sigma_3$. In other words, all the axisymmetric loadings may be represented on the Rendulic plane. It also plots any experimental points that lie on these two meridians.

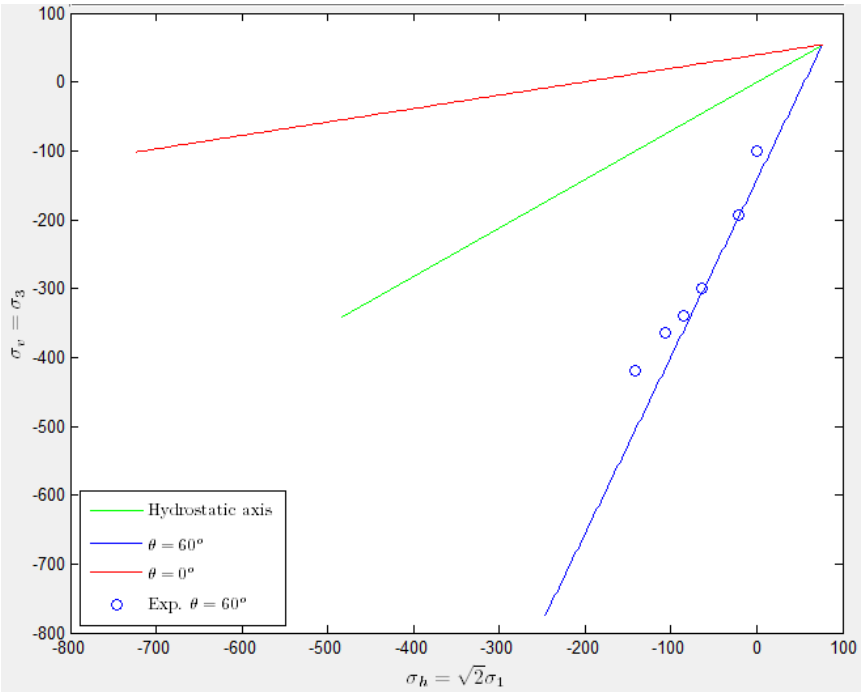


Figure 10: Rendulic Plane plot

σ_2-σ_3 Plane

The *σ_2-σ_3 Plane* option plots the traces of the failure surface on the σ_2-σ_3 plane for several σ_1 values (Figure 11). The σ_1 groups are calculated by the experimental data, i.e. the data are split into groups with the same σ_1. On the same diagram, the experimental points are, also, plotted grouped by σ_1.

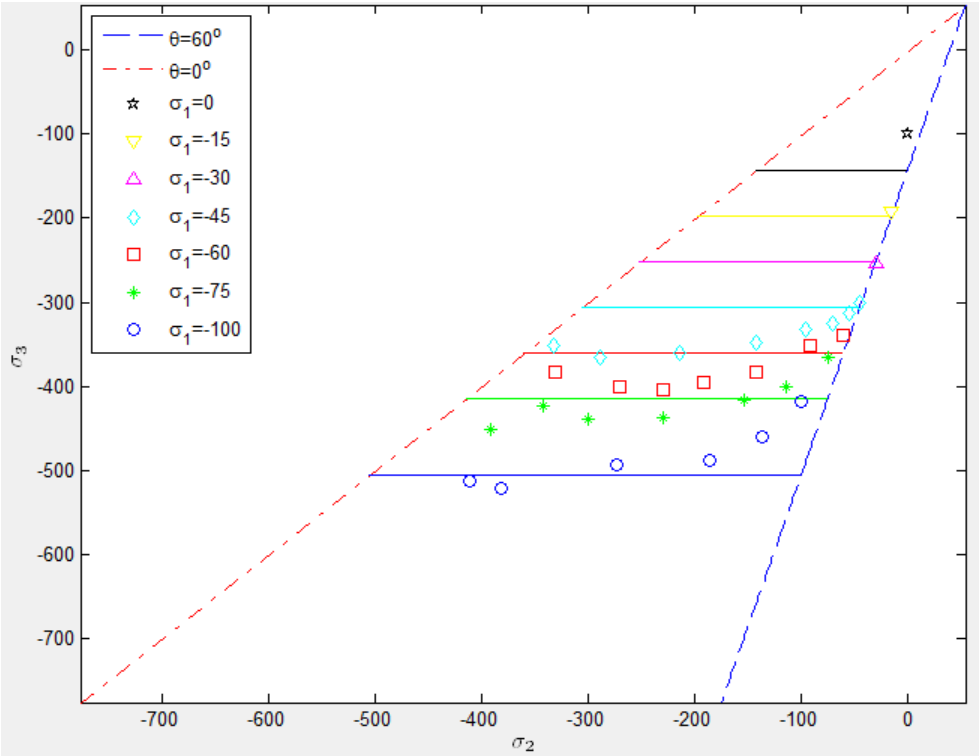


Figure 11: σ_2-σ_3 Plane plot

Residuals Polar Diagram

The *Residuals Polar Diagram* option plots a filled contour of the residuals of the experimental points (Figure 12). The diagram is in polar coordinates. The radial distance is the mean pressure measured from the equitriaxial tensile strength point. The angle is the Lode angle θ. The color map shows the difference between the experimental $T^{(\exp)}$ and the predicted $T^{(\mathrm{model})}$ by the calibrated failure criterion. The experimental points are also plotted for reference.

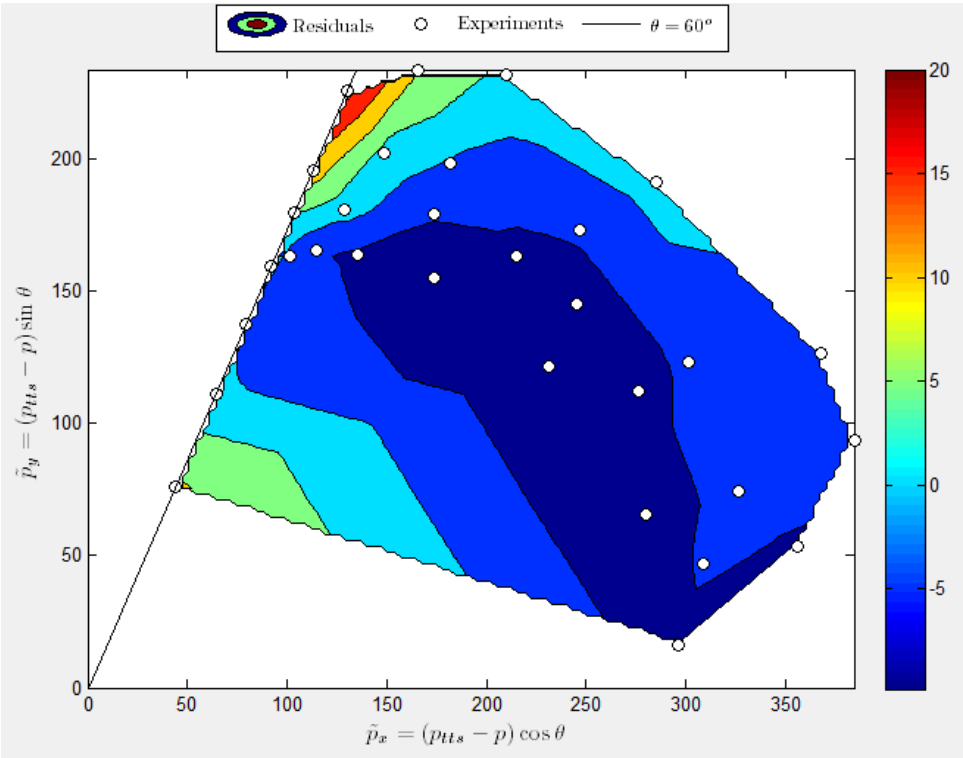


Figure 12: Residuals Polar Diagram plot

Residuals Histogram

The *Residuals Histogram* option plots a histogram of the residuals (Figure 13). A good prediction increases the number of residuals with value near to zero.

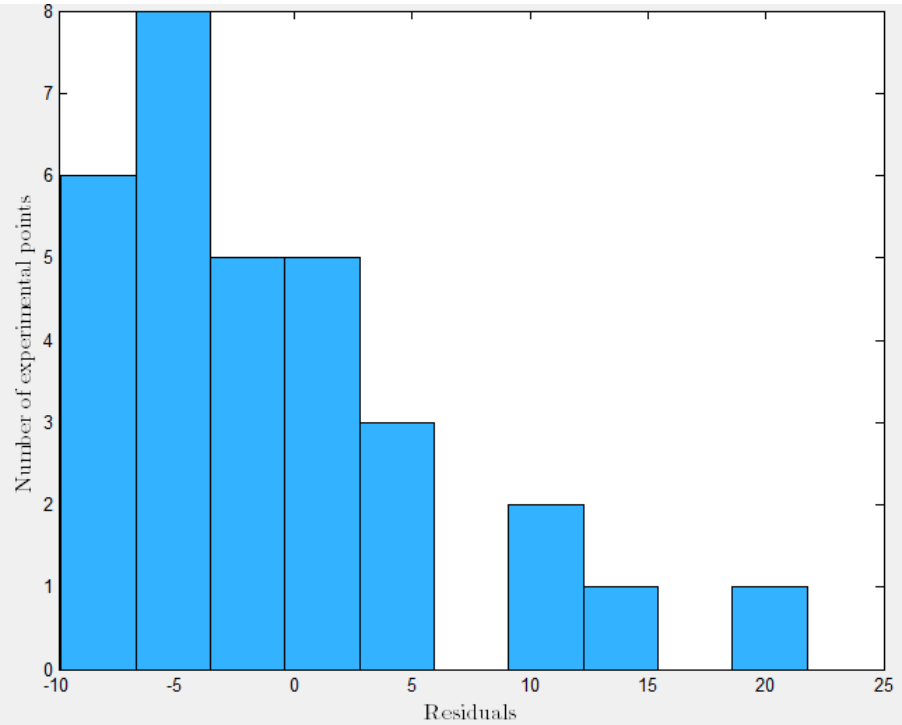


Figure 13: Residuals Histogram plot

Plot tools panel

Every plot has a *Plot tools* panel with available plot manipulation options (Figure 14). The *Rotate 3D* option is available only for the *Failure Surface* plot. *Zoom* and *Pan* options are available on all plots except from *Failure Surface* and *Residuals Histogram* plots. Finally, *Grid* option is available on all plots.

Figure 14: Plot tools panel

Directory Structure

The directory structure of the FCMODEL application is illustrated in Figure 15.

```
fcmodel
    |----  data
    |----  functions
    |----  models
```

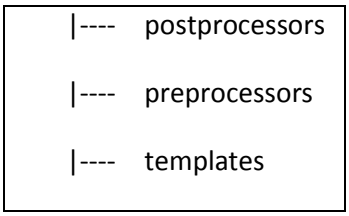


Figure 15: Directory structure of FCMODEL application

The directories contain the following functions/files:

data Sample files with experimental data. The user may store his own data files here or in any other directory of his choice.

functions Internal functions of the application.

models Objective functions of the failure criteria. All the objective functions of the build-in models are stored in this directory. The objective function of every new criterion provided by the user must be stored in this directory.

postprocessors Post-processors of the failure criteria. All the post-processors of the built-in models are stored in this directory. The post-processor of every new criterion provided by the user must be stored in this directory.

preprocessors Pre-processors of the failure criteria. All the pre-processors of the built-in models are stored in this directory. The pre-processor of every new criterion provided by the user must be stored in this directory.

templates Templates for building new failure criteria. An objective function, a pre-processor and a post-processor template are supplied.

Building New Failure Criteria

The FCMODEL application may be extended to support new failure criteria provided by the user. For every new criterion an objective function, a pre-processor and a post-processor must be provided. The *templates* directory contains template files for the three functions required. The three files must be stored in the corresponding directories.

Objective function

The objective function is the failure criterion in the form of Eq. (2). The declaration of the function (first row) must be in the form:

```
function [T,J]=model(x,p,theta)
```

where *model* is the name of the function. The model name must be exactly the same with the file name.

Parameter *x* is a row array containing the parameters of the failure criterion. The order of the parameters is defined by the user. Parameters *p* and *theta* are column arrays containing the mean pressure and the corresponding Lode angle. The FCMODEL application supplies these arrays automatically. The user must supply in the function the necessary calculations in order to calculate the octahedral shear stress *T* from *x*, *p* and *theta*. *T* must be a column array. Each value of *T* is calculated by the corresponding (*p, theta*) pair from the input.

Parameter *J* is the Jacobian of the objective function with respect to its parameters in the *x* array. In other words, *J* is a matrix containing the partial derivatives of *T* with respect to each parameter in *x*. The columns of *J* are equal to the columns of *x*. The rows of *J* are equal to the rows of *p* and *theta.* The order of the derivatives (columns) must be exactly the same with the order of the parameters in *x*. The calculation of the Jacobian is optional. The algorithm calculates the Jacobian numerically if it is not provided by the user.

For more details on building functions please consult MATLAB's documentation.

Pre-processor

The pre-processor initializes the parameters of the failure criterion. The pre-processor function must be declared in the form:

```
function [titlestring,x0,lb,ub,jac]=modelpreprocessor
```

where *modelpreprocessor* is the name of the pre-processor. To construct the name of the pre-processor, append the string "preprocessor" to the model's name. For example if the name of the objective function is "objfun1" then the pre-processor must be "objfun1preprocessor". You must always follow this pattern in order for FCMODEL to be able to locate the pre-processor.

The preprocessor has no inputs. The *titlestring* parameter is a string containing the name of the failure criterion. The *titlestring* will appear automatically in the drop down list of the available failure criteria. Parameter *x0* is the initial guess row array of the parameters of the model. *lb* and *ub* row arrays are the lower and upper boundary values for the parameters. Infinity is also allowed (open boundary). *jac* is a string declaring if the Jacobian of the objective function will be provided by the model function. Available options are "on" and "off".

Post-processor

The post-processor performs calculations and data manipulations after a successful calibration. The post-processor must be declared in the form:

```
function [ptt,results]=modelpostprocessor(x)
```

where *modelpostprocessor* is the name of the post-processor. To construct the name of the post-processor please follow the same pattern as with the pre-processor by appending the "postprocessor" string to the model name.

x is the row array of the calibrated parameters and it is supplied by FCMODEL. *ptt* is the hydrostatic (equi-triaxial) tensile strength. The *ptt* value is usually a singular point, thus its calculation must be provided by the post-processor given the calibrated parameters in *x*. The *results* parameter is a column cell array. Each row is a string containing a calibrated parameter. FCMODEL application does not know what each parameter is; hence the post-processor must provide the description. For example if the first parameter in *x* array is the cohesion *c* and the second parameter is the friction angle *φ*, then the *results* array can be defined as:

```
results={strcat('c=',num2str(x(1)));
    strcat('phi=',num2str(x(2)*180/pi))};
```

The *results* array is displayed in the *Calibration Results* panel of the FCMODEL application.

6. Vulnerability of structures database, blast and earthquake (CIMNE)

The background and DESURBS advances for the vulnerability of structures database are reported in D4.8.

A demonstration of the use of this tool can be found in a 4- part series of short videos that are downloadable from the following link:

https://web.cimne.upc.edu/users/zarate/DESURBS/Videos

7. Conclusion

In this deliverable, we have provided short user manuals for the DESURBS WP4 supporting tools.